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# Engineering and Mining Journal

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Magnetic Separation Up to Date

Diesel Power in the South Seas

Advance in Flotation

Sound Copper Sheets by Electrolysis

Continuous Lead Refining at Port Pirie

Scrap Metal in the Copper Market

JULY 1933

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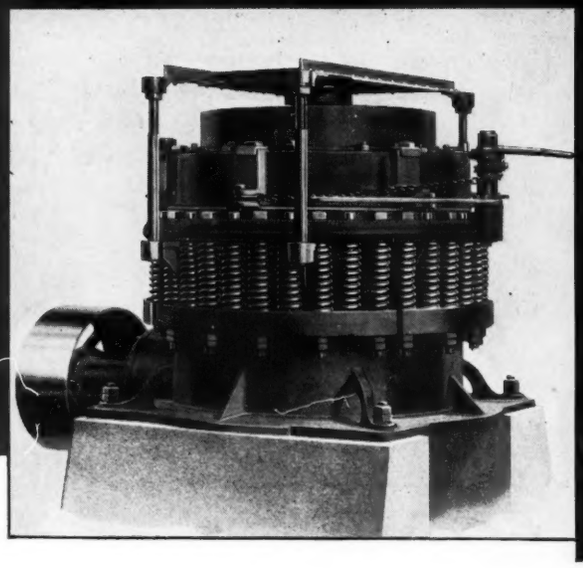

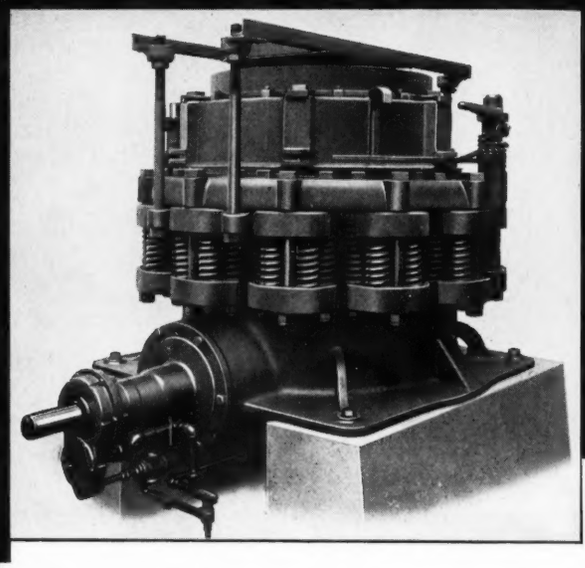

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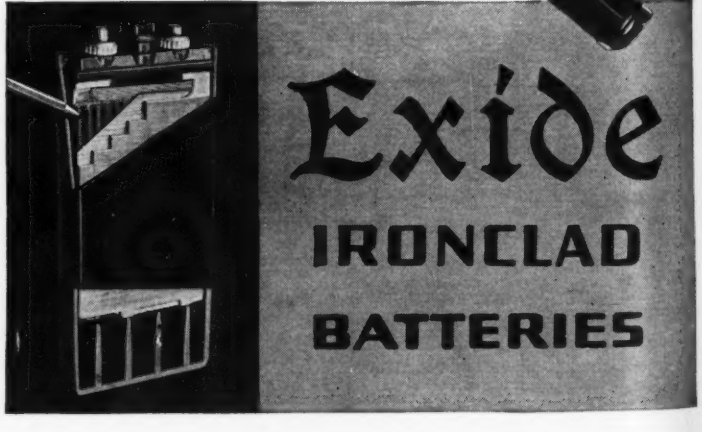


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Engineering and Mining Journal

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H. C. PARMELEE, *Editorial Director*

JULY, 1933

# Moving Toward Recovery

SWINGING SWIFTLY into action following the passage of the Act by which it was created, the National Industrial Recovery Administration set a timely and inspiring example to American business in the promptness with which it announced its personnel and plan of action, and interpreted the covenant under which the Government proposes to set up a partnership with industry. Evidently a vast amount of preliminary work had been done while the bill was still before Congress. General Johnson, Administrator-to-be, had enlisted the aid of co-workers and had perfected an organization in greater detail than many had imagined—all reminiscent of the feverish activity of 1917.

That the details confronting the administration of the Act are diverse and complex as American business itself, cannot obscure its principal purpose, which is to put men back to work. The President made that clear in a statement issued when he affixed his signature to the new charter of American business. And General Johnson has since repeatedly emphasized this point, urging industrial groups "to submit without delay a basic code covering only such agreements as are consistent with the policy of the Act, respecting maximum hours of labor, minimum rates of wages, and such means as each industry may find necessary to protect its constructive and cooperating majority from the wasteful and unfair competition of minorities or recalcitrants." Simple adherence to the fundamental policy of the Act is the first requisite. Refinements and modifications can be worked out later.

There are obvious reasons why the Administration invites basic codes covering large industrial groups. Chief is the fact that a multiplicity of codes relating to small groups would cause delay in preliminary hearings and final approval by the President. Already about 100 codes have arrived in Washington for preliminary consideration, and hundreds more are in preparation. The sheer physical task of hearing so many proposals is something that Administrator Johnson and his deputies may well wish to avoid in the interest of prompt and speedy action. So the line of procedure is clearly marked: prepare relatively simple codes, embodying the mandatory provisions of the Act and covering as large an industrial group as possible. When this code is approved, amendments and modifications can be submitted embodying pertinent details that would be out of place in the basic code.

President Roosevelt has expressed the hope that the major industries providing the bulk of industrial employment will submit their basic codes at once, so that July will witness the great national movement back to work. Although he did not specifically mention the metal mining industry, nevertheless it is one of the major industries of the country and should prepare for early action. Metal mining and its related activities has employed well over 100,000 men, and in due course can again make its contribution to industrial recovery.

If the metal mining industry follows the expressed preference of the Administration it will submit promptly a basic code covering hours and wages of labor, giving due consideration to varying conditions in different parts of the country, the requirements of the industry and the state of employment therein. Amendments can also be offered for major or minor metal groups, covering trade agreements with respect to reports, methods of cost accounting, marketing, price cutting, production quotas, arbitration, and the like. These are the control sanctions that will be granted in return for the basic agreements relating to labor. The law itself provides against unfair competition from imports that endanger the maintenance of any code.

We have no illusions regarding the complexity of the problem confronting the metal mining industry, but we urge the most sincere effort to meet the wishes of General Johnson in the first instance. Any other procedure is likely to entail costly delay that will defeat the purpose of the Act.

## Is Gold Mining the Forgotten Industry?

RECENT DEVELOPMENTS here and abroad seem to indicate that an early return to a gold currency basis by the United States is improbable. Rising commodity prices in the near future, moreover, seem assured. For the gold miner these prospects have a decidedly discouraging significance: his costs cannot fail to increase, and, if he is operating on a small margin of profit now, suspension of further mining will probably be inevitable. The larger companies, principally by mining high-grade ore, will undoubtedly be able to carry on and to offer employment to a limited number of workers. Many of the smaller companies, on the contrary, can be expected to dissolve; and loss of their present means of obtaining a livelihood will apparently be the lot of most of the thousands of individuals in the Western gold states who last year were able to sustain themselves through small-scale gold-mining projects.

Granted that holding of or dealing in gold—to quote from recent national legislation—affects the public interest and therefore is subject to proper regulation and restriction, means should be provided, in the event of currency inflation, whereby the gold miner can obtain for his product an increased price commensurate with the higher prices that will then accrue to the producers of other commodities. And granted that the present dollar premium on gold in the world market exists primarily as the result of the country's abandoning the gold currency basis, serious consideration would seem desirable on the part of the Government to the thought that the export of newly mined gold be permitted.

In brief, gold mining is one of the established industries of the United States. Although it does not enjoy quite as vital a position as it once did in the nation's economic structure, it is still a highly important part of the industrial life and wealth of the country. To ascribe to it, even in these days of national experimentation, the rôle of the forgotten industry would seem unjust.

## That Four Million Penrose Bequest

WHEN WAYS must be devised for spending the income, if not the principal, of such a tidy sum as the $4,000,000 bequeathed the Geological Society of America by the late R. A. F. Penrose, Jr.—a bit of news now more than a year old and still somewhat startling—the free-will offering of multitudinous suggestions may be expected. One contribution, as it were, begets another. Flies will gather around a honey pot, and chiselers (if we may risk an Americanism) can see a fund, even one of modest size, more easily than a geophysical prospector can detect an orebody. Aside from these, many learned members of the profession have given the matter their earnest consideration.

Information as to how the Geological Society will use its inheritance has not as yet been widely circulated. Report states that the organization has broadened its publishing plan and adopted an interesting program of research. Conservatism and slow procedure will naturally mark its course. Better this than hasty spending.

Much can be done to increase the practical value of geological knowledge and to disseminate it widely. Many a reader of this magazine could doubtless make a suggestion worthy of attention. Much factual information as to the rocks and orebodies of the mining districts of the world remains to be compiled and correlated. So simple a matter as the relative hardness of formations is largely one of guesswork, making difficult if not impossible the comparison of drill performance, tunnel driving and shaft sinking in different districts. Some may incline to dismiss this hint as trivial, and yet one can safely say that every drill manufacturer and many engineers would find the data valuable.

## Iron-Ore Taxation in Minnesota

DEFLATION has emphasized taxation. Where the burden of the latter was already heavy before the price decline set in, and nothing has been done to lighten it, the situation, as for instance in the Lake Superior iron-ore industry, might better be left to the imagination than described. Especially in Minnesota has iron mining thus been handicapped. The load borne by the operators is truly staggering. One may ask, how long can they bear up under it?

As compared with other forms of property, iron ore in Minnesota, whether it be mined or left in the ground, is assessed for taxation purposes at the highest rate. In addition, it is subject to specific taxes that other property escapes and, besides, must stand exorbitant levies imposed by the communities within whose borders it occurs. In more detail, the assessment rate is 50 per cent of the full value, compared with 40 per cent for platted real estate and 33⅓ per cent for agricultural farm property; the taxes, in addition to the general ad valorem and personal property levies, include a 6 per cent occupation tax, levied on the difference between the cost and the selling price of the iron ore, cost being calculated in such a way as to make the tax actually higher than 6 per cent; also a 6 per cent royalty tax, which the courts have ruled is payable by the operator; and last and heaviest of all, the local levies mentioned. The total tax tells the story: in 1932, the mining companies of Minnesota paid $18,650,166, although ore shipments were but 2,287,000 tons, the smallest tonnage in 40 years. Inasmuch as the base selling price of ore at lower Lake ports was $4.50 to $4.80 per ton, depending on the grade, the taxes paid last year greatly exceeded the gross value of the shipments. Even in the peak year 1929, when approximately 46,000,000 tons was shipped, the taxes exceeded the total amount of money paid for labor.

An iniquitous feature of the taxation system in vogue is that the ad valorem tax is payable whether the ore is actually mined or remains in the ground. Thus it happened that in 1931, when about 17,000,000 tons was shipped, or more than seven times the shipments of

1932, the total taxes paid were less than 2 per cent greater than those of the latter year. Such a policy tends to cause the production of unwanted ore, thereby to pile up surpluses and to lower prices, and to deplete ore resources at an unduly rapid rate.

The tale would be incomplete without further mention of the local levies, in particular those imposed by the various municipalities of the Mesabi on the iron ore within their respective borders. As the solicitor for the largest operator on the Range has recently pointed out, these levies are five to ten times as high as those of communities of similar size elsewhere in the State. The tax yield per capita in the principal municipality has averaged about $100, against $15 elsewhere. And the expenditures of these towns and villages have kept pace nobly with the levies. Part of the money has been spent to provide excellent schools and other facilities, but much has undeniably been wasted. Little has been done to insure a future for the chief communities, that are now so attractive to the visitor.

Evidently, the majority of those who wield the ballot in Minnesota believe that the ore resources of the State should yield the people a generous income, irrespective of the ownership. But however wise it may seem to them in normal times to take for themselves a large share of the gross earnings of the industry, the changed conditions of today must surely have caused them to perceive that a modification of their taxation policy is advisable. Or is virtual confiscation their objective?

## Progress in Lead Metallurgy

CROWNING the achievements of years of effort to coordinate efficiently the elements of its great enterprise, the Broken Hill Associated Smelters Proprietary, of Australia, has scored new and important advance in the metallurgy of lead. In the various steps incidental to the refining of its bullion at Port Pirie, the company has finally discarded time-honored batch methods of working in favor of continuous processes. Desilverizing, degolding, softening, and refining have all been made continuous, after long study and experiment begun more than a decade ago. The story is told elsewhere in this issue. The new refinery, erection of which was decided upon in 1931, occupies a site half as large as that of the former, has greater capacity, and turns out better products. The more rapid treatment expresses itself in lower costs for fuel, labor, and maintenance. Thus one sees that in the post-war period, while financiers and captains of industry far and wide were following a course leading to disaster, the Broken Hill metallurgists were engaged in work that was to make their company better able to cope with lower metal prices. Justly they may be proud of the result. In them is typified once again the engineer striving for the good of mankind.

The Port Pirie plant stands alone in its new distinction. Refiners elsewhere are cognizant of what has been accomplished, and admiringly accord due credit to the Broken Hill staff. If they do not at once modify their practice, they doubtless have sufficient reason. Those operating custom plants, and handling in the same kettles leads that vary greatly in composition, may prefer to study the problem longer from their own respective viewpoints. Before the erection of a new refinery is undertaken by anyone in the future, the possibility of adopting continuous practice will in all likelihood have been thoroughly considered first.

## End of Deflation Lifts Prices

GENERAL IMPROVEMENT in economic conditions, particularly the outlook for the near future, is reflected in the advance in commodity prices, in which non-ferrous metals have played no small part. The first showing of sustained strength in the metal market occurred in early March. Last February the weighted index of non-ferrous metal prices of *Engineering & Mining Journal* was 44.79, but it rose to 64.12 in June. Although the low point for the depression occurred last summer, at which time our index dropped to 44.77, few in close touch with trading in metals in the United States at that time experienced a feeling of such utter helplessness as that which attended the collapse of the banking structure early this year.

Prices fell for lack of purchasing power in the hands of those in need of the world's goods. The scramble to convert everything into liquid assets forced prices down to distress levels. Picture copper at 5c. a pound, delivered to the plant of the fabricator. Lead declined to 2.650c., New York, and Prime Western zinc to 2.275c., St. Louis. Silver reached a low of 24.250c. an ounce. Consumers disposed to accumulate raw materials at prices far below cost of production were advised to ride out the storm with cash rather than commodities. The cry was for money, not things.

Producers made valiant efforts to support prices by balancing production and consumption. But despite all the measures adopted, no one was able to foretell the extent to which demand was contracting. Nothing short of complete cessation of production seemed to point a way out.

Failure of the banks to open in this country on March 6 was followed by an abrupt change in political temper. The Administration announced that measures would be adopted to end deflation. Uncertainty over what might be the ultimate fate of the dollar, suddenly made copper appear as a good investment at 5c. a pound. The same held true of all useful commodities, and surplus stocks lost some of their liability aspect. Money began to circulate and business was stimulated. Some may contend that recovery came about through natural causes, but in view of what took place shortly before prices emerged from the depth to which they had sunk, one seems justified in believing that the drastic steps taken to end deflation really started the drift toward equities.

World prices for copper, silver, and tin have already responded to the improvement in business that now happily illuminates the American scene, and evidence is accumulating that the economic machine will again be brought into reasonable balance. The trend in the United States market is indicated in the substantial percentage rise in price scored by the principal metals over their respective lows during the depression. Copper has advanced 60 per cent, lead 58, and zinc 94.

*Harris and Ewing*

# H. S. Johnson

**Administrator of the U. S. National Industrial Recovery Act**

◆

**A Man with whom the Mining Industry will have much to do**

◆

MANY NAMES have already been bestowed by the daily press on the man selected by the Washington Administration to head its program for national industrial recovery. They have ranged from "dictator of industry" to "umpire," "organizer," and "disciplinarian." All of these, save the first, are warranted by General Johnson's distinguished record, both as a member of the War Industries Board in 1918 and other official bodies before and since; as a soldier-lawyer in important posts; and as a business executive. "Dictator" is a term distasteful to him. Yet his powers with respect to business under the newly enacted law will be greater than any possessed before by an individual in the United States, save a President in wartime. Similarly, he dislikes to talk of "industrial control," yet the control that he can exercise over industry, if he sees fit, has been unknown hitherto in this country. Physiognomy (see above) and anecdote testify that he means what he says and gets what he wants. Report has it that he prefers to deal with the mining industry through one agency, not several organizations or associations. Operators and executives will do well to govern themselves accordingly.

# MAGNETIC SEPARATION

## An Up-to-Date Mill

*H. M. Roche*

and

*R. E. Crockett*

*Finely disseminated magnetite ore is mined at Scrub Oak, New Jersey. As delivered to the mill it contains 33 per cent iron, 0.075 per cent phosphorus, and 36 per cent silica. Of the total iron, 18 per cent is martite, a non-magnetic oxide. Evolution of magnetic separation practice at the plant was discussed in the June issue. The mill and the milling results are here described in detail.*

ORE PREPARATION at the Alan Wood Mining Company's Scrub Oak plant begins underground. The flowsheet of the dry-crushing and screening unit, including the underground crusher layout on the second level of the mine, is shown on another page. After passing through underground grizzlies having 18-in. by 5-ft. openings, the ore is trammed in 5-ton cars to a 600-ton underground bin. From this it passes via a Worthington 60-in. heavy-duty pan feeder to a 30x42-in. Buchanan jaw crusher, driven by a 100-hp. motor. Set to 6 in., this has a capacity of 175 tons per hour at 200 r.p.m. The crushed product passes into a 500-ton bin, thence by air-controlled measuring chutes to 5-ton skips and thence to surface to an 800-ton bin. Moisture in the ore, as hoisted, varies from 1 to 4 per cent.

### Screening

Underground crushing has speeded up stoping, tramming, and hoisting and reduced blockholing. Since its adoption, the grizzly spacing has been increased from 11 to the present 18 in. and the cost of blockholing reduced from 30 to 8c. per ton. Other savings, difficult to calculate, were made by increasing hoisting speed and drawing faster from stopes. Underground crushing cost is 5c. per ton, including depreciation and other carrying charges.

From the 800-ton bin, the ore is delivered by a 3x7-ft. shaking plate feeder making 60 3-in. strokes per minute, at the rate of 90 long tons per hour, to a 42x72-in. Robins-Gyrex screen, to remove any fines, which may be wet or damp. The screen vibrating shaft turns at 900 r.p.m. Screen surface slopes 15 deg. and is made of $\frac{3}{8}$-in. plate with $1\frac{1}{4}$-in. square openings. Oversize goes to a 48-in. 6-ply, rubber-covered picking belt on which tramp iron and waste wood are removed. This delivers to a $5\frac{1}{2}$-ft. Symons cone crusher.

The crusher is operated at 525 r.p.m. with a $\frac{5}{8}$-in. head-throw. Set to $\frac{1}{4}$ in., it produces a product 75 per cent minus $\frac{5}{8}$-in. size. The fines are removed, lest the crusher horsepower required be increased because of packing. The crude ore, as hoisted, contains about 25 per cent minus $1\frac{1}{4}$-in. material, and inasmuch as it is delivered to the mill at a rate of 90 tons per hour, the screen undersize is 22.5 tons per hour. The crusher is thus fed 67.5 tons per hour.

Screen undersize, when the moisture is 1 per cent or under, is delivered by a 20-in. conveyor to the belt feeder of the No. 1 rolls, to be discussed hereafter. If it contains more than 1 per cent it is dried in a Rowand tower dryer to permit efficient screening of the finer sizes. The tower is 5x5 ft. inside and 45 ft. high, and can reduce 25 tons per hour from 4 to 1 per cent moisture content, using natural draft. With a bottom blower and a top exhauster, its capacity can be increased with much wetter ores.

The cone crusher discharges on to a 30-in. conveyor running beneath it and the rolls. This delivers to a cross conveyor (included in the series of 30-in. conveyors shown in the flowsheet) 30 in. wide, which also receives the tower dryer discharge. By this conveyor and two other conveyors the crushed and dried ore is elevated 83 ft. and delivered to screens over the crushed ore bins.

The first screen serves as a scalper, and is a single-deck, 4x5-ft. Hum-mer with a V-64 vibrator and end suspension for the screen cloth. The screening surface is of wire cloth with 2-in. square openings. Wood chips, tramp iron, and flat rock are here removed and sent to waste. In the crusher the wall rock breaks into flat slabs or chips, which can be scalped without loss.

### Roll Crushing

Scalper undersize goes to four 5x8-ft. single-deck Hum-mer screens, each equipped with two V-32 vibrators and with end suspension for the cloth, which has $\frac{5}{8}$-in. square openings. Oversize is conveyed to the 300-ton No. 1 roll bin, to be recrushed. Undersize goes to four other Hum-mer screens, similar to the preceding four, save that the screening surface is No. 661 Ton-Cap. Oversize of the latter goes to the 600-ton No. 2 roll bin for further crushing. Their undersize, which is the finished minus-8 mesh product of the crushing plant, and includes the minus-8 mesh product of the rolls, because the latter are in closed circuit with the screens, is conveyed to the concentrating section. The ore is weighed en route by a Chatillon Telepoise conveyor scale. Table IX[1] shows a screen analysis of this finished product.

As already stated, the rolls are in closed circuit with the screens. There are two circuits, No. 1 rolls being in closed circuit with the first four Hum-mer screens and No. 2 rolls with the remaining four.

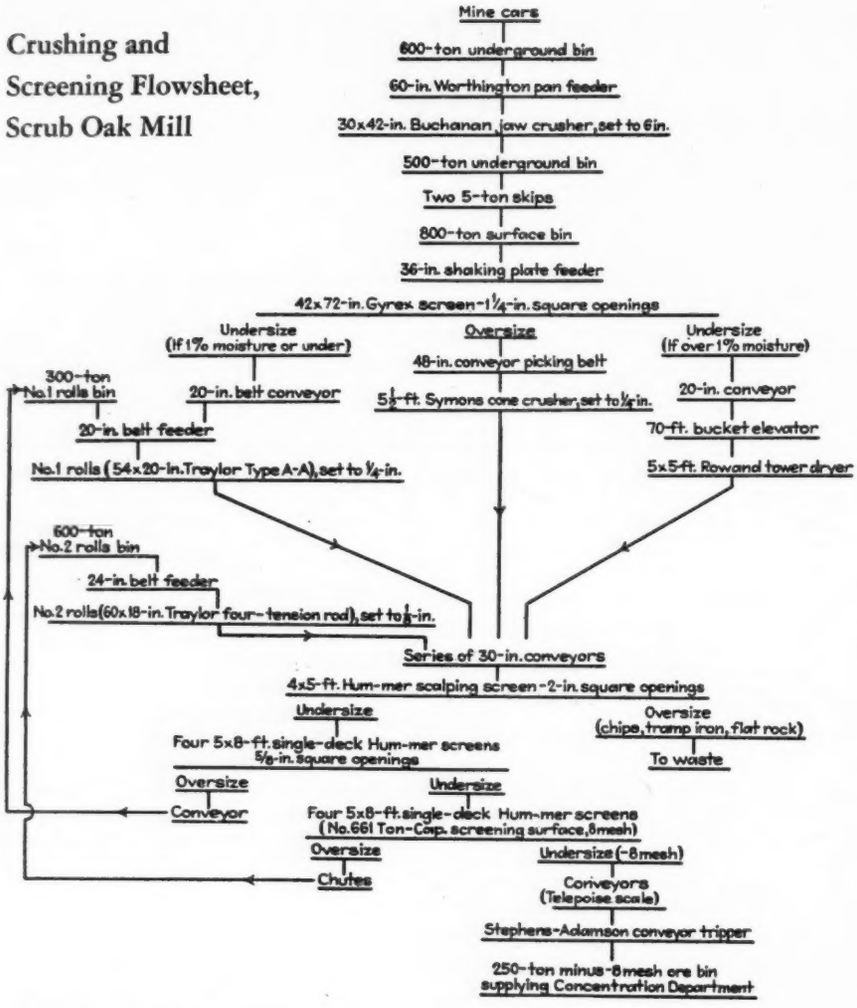
### Feed Varies

From the No. 1 roll bin ore is delivered by a 20-in. flat belt feeder, moving at 250 ft. per minute, to a 54x20-in. Traylor heavy-duty Type AA set of rolls. These are set to $\frac{1}{4}$ in. and run at 110 r.p.m. Their feed is the minus-$1\frac{1}{4}$ in. undersize of the Gyrex screen, unless this is bypassed to the dryer, and the oversize of the $\frac{5}{8}$-in. Hum-mer screens, with which they are in closed circuit. If the undersize of the Gyrex screen is bypassed to the dryer, the plus $\frac{5}{8}$-in. material in it goes also to these rolls. The amount of feed thus varies, but the capacity in closed circuit, crushing from 1 in. to $\frac{1}{4}$ in., is about 50 tons per hour. Their product is discharged on the 30-in. conveyor, which also takes the cone crusher discharge.

From the No. 2 roll bin ore is delivered by a 24-in. flat belt feeder at 250 ft. per minute to a 60x18-in. set of Traylor four tension rod type rolls. These are set at $\frac{1}{8}$ in. and run at 120 r.p.m. Their capacity on Scrub Oak ore, with choke feeding, is 75 tons per hour of finished product, crushing from minus $\frac{5}{8}$ in. to minus 8 mesh. They are in closed circuit with the No. 661 Ton-Cap Hum-mer screens, and the circuit is built up to 150 tons per hour. Their product is also discharged on the 30-in. conveyor, which serves the cone crusher and the No. 1 rolls.

[1]Tables I-VIII appeared in preceding articles.

**Crushing and Screening Flowsheet, Scrub Oak Mill**


Mine cars
600-ton underground bin
60-in. Worthington pan feeder
30x42-in. Buchanan jaw crusher, set to 6in.
500-ton underground bin
Two 5-ton skips
800-ton surface bin
36-in. shaking plate feeder
42x72-in. Gyrex screen-1¼-in. square openings
Undersize (If 1% moisture or under)
Oversize
Undersize (If over 1% moisture)
48-in. conveyor picking belt
300-ton No.1 rolls bin
20-in. belt conveyor
5½-ft. Symons cone crusher, set to ¼-in.
20-in. conveyor
20-in. belt feeder
70-ft. bucket elevator
No.1 rolls (54x20-in. Traylor Type A-A), set to ¼-in.
5x5-ft. Rowand tower dryer
600-ton No.2 rolls bin
24-in. belt feeder
No.2 rolls (60x18-in. Traylor four-tension rod), set to ⅜-in.
Series of 30-in. conveyors
4x5-ft. Hum-mer scalping screen-2-in. square openings
Undersize
Oversize (chips, tramp iron, flat rock)
Four 5x8-ft. single-deck Hum-mer screens ⅝-in. square openings
To waste
Oversize
Undersize
Conveyor
Four 5x8-ft. single-deck Hum-mer screens (No.661 Ton-Cap. screening surface, 8mesh)
Oversize
Undersize (-8mesh)
Chutes
Conveyors (Telepoise scale)
Stephens-Adamson conveyor tripper
250-ton minus-8mesh ore bin supplying Concentration Department

Under capacity conditions, new feed is delivered to the mill at the rate of 90 tons per hour, and the circulating load is about 110 tons, or a total of 200 tons per hour. This is handled by the 30-in. conveyors and the screens. The single scalping screen also handles this tonnage, but with 2-in. square openings and the heavy-duty vibrator no trouble is experienced. The ⅝-in. screens have an area of 160 sq.ft. and a feed of 200 tons per hour. This is equivalent to 1.25 tons per hour per square foot of screen. The No. 661 Ton-Cap screens have an area of 160 sq.ft., and the undersize of the ⅝-in. screens, which constitutes their feed, amounts to 160 tons per hour.

The total connected motor load in the crushing and screening unit is 463 hp., which serves to (dry) crush 90 long tons per hour from 6 in. to minus-8 mesh, or 5.144 hp. per ton of finished product. Scrub Oak ore is hard and abrasive, the principal gangue being silica.

## Concentration

The concentration unit flowsheet is shown herewith. The minus-8 mesh product of the crushing and screening section is conveyed to a 250-ton bin, and there distributed by a Stephens-Adamson automatic tripper.

Ore is fed from the bin to magnetic separators by six 6-in. screw feeders at the rate of 15 long tons per hour per feeder, dropping into 45-deg. launders. Here water is added. Screen analysis of the feed is shown in Table IX. No classification precedes separation. The launders deliver the ore to six Roche wet belt magnetic rougher underfeed separators. These are the primary roughers and are 36 in. wide, run at 200 ft. per minute, and take direct current for excitation of the magnets at 14 amp., 125 volts. On Scrub Oak ore, the capacity of each is 15 long tons per hour. A tailing and a rougher concentrate are made.

The rougher concentrate is next treated on six Roche wet-belt, magnetic finisher, top-feed separators. These are the primary finishers. They are 36 in. wide, run at 200 ft. per minute, and have a capacity of 10 long tons per hour. Field strength is controlled by varying the circuit amperes, a very sensitive adjustment. A small change in amperes makes a considerable change in the recovery and in the iron content of the products. In making a 60-per cent iron concentrate at Scrub Oak these machines take 6 amp. at 125 volts.

Two products are made by the finisher separators—a middling for recrushing and a concentrate. The former is sent to a 16-in. flat drag conveyor and delivered to a Traylor 5x10-ft. rod mill. Concentrate is similarly conveyed to dewatering drag. Rod-mill discharge is returned by a No. 4 Wilfley sand pump to the magnetic separator floor to a four-way splitter and delivered to four Roche wet-belt secondary rougher separators, which make tailing and rougher concentrate. Tailing joins that made by the primary roughers, and the concentrate is sent to four Roche wet-belt secondary finisher separators, which make middling and concentrate. This middling is combined with the primary middling and returned to the rod mill. Concentrate is combined with the primary concentrate. In size, capacity, and characteristics the secondary separators are identical with the primaries.

## Circuits

Both the primary rougher and finisher machines are operated in open circuit; the secondary rougher and finisher separators in closed circuit with the rod mill. The latter, crushing to minus-20 mesh, has a small circulating load, which becomes fine enough on the second pass to be separated into tailing and concentrate. Final product of all separators is tailing and concentrate. The magnetic concentration is three-part separation in two stages, with elimination of tailing by rougher separators as the first step in each stage and cleaning of rougher concentrates by finisher separators as the last step in each stage. To effect this three-part separation, roughers and finishers, in series, are used.

The six primary roughers receive their feed at the rate of 90 tons per hour and make a tailing and a rough or low-grade concentrate. Out of the 90 tons fed, 41.92 tons of tailing is produced by the primary roughers (Table X). Removal of tailing as the first product of the magnetic circuit reduces the amount of material to be treated subsequently; also the equipment needed.

## Controlling Grade

The furnace specification for Scrub Oak concentrate is 60 per cent iron and 10 per cent silica, and the concentrate is so made. However, any grade can be made with the concentration unit flowsheet. The magnetic pull on the roughers is fixed or constant, so as to make low-grade tailing at all times, but that on the finisher separators is variable. By varying the attractive force, any grade of concentrate, in iron, can be made. The load of middling feed sent to the rod mill will increase in proportion to the increase in iron in the concentrate, because finer grinding is necessary to make higher iron.

Tables X and XI show that from 90 tons of crude ore running 24.6 per cent magnetic iron, 54.2 tons of tailing running 1.20 per cent magnetic iron, and 35.8 tons of concentrate running 60 per

cent magnetic iron, are made. Table IV (June issue, p. 242) shows the ratio of concentration and percentage of recovery of magnetic iron units.

The crude ore at Scrub Oak will average 33 per cent total iron before mining. During the four months the new mill was in operation the ore hoisted averaged 30 per cent iron. The decrease in grade was caused by dilution with an unusual amount of development rock, incidental to reopening the mine.

As milled, the ore contained 24.6 per cent magnetic iron and 5.4 per cent non-magnetic iron. The magnetic separator tailing ran 1.20 per cent magnetic iron and 8.97 per cent non-magnetic, or 10.17 per cent total iron. Shaking tables recover the non-magnetic iron, their feed being the magnetic separator tailing, which amounts to 54.2 tons per hour. This tailing is elevated by a No. 8 Wilfley sand pump to the top of the mill for classification before tabling.

## Classification

Here it goes to a two-way splitter, discharging to two 4-ft. Allen sand tanks, the spigot product of which forms the feed of eight Deister Plat-O coarse sand tables. Overflow goes to two 6-ft. Allen sand tanks, the spigot discharge, the latter being fed to eight Deister Plat-O medium sand tables. Overflow of the tanks goes to a three-way splitter and then to three 10-ft. Allen cones. Spigot discharge of the latter goes to four Deister Plat-O fine sand tables and the overflow to a Dorr thickener.

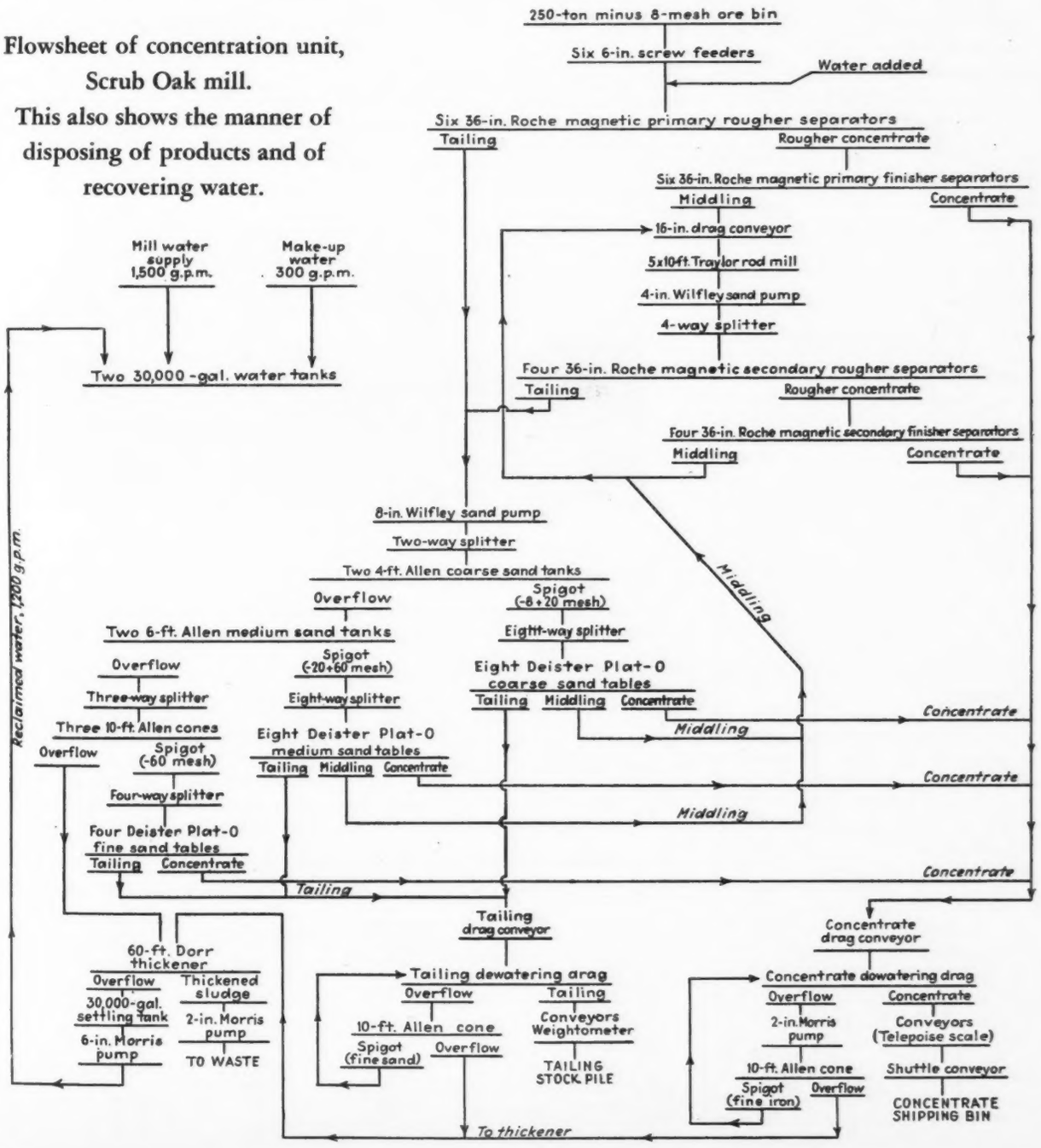
Thus the table feed is roughly classified into three sizes by the Allen tanks and cones: minus 8 plus 20 mesh, minus 20 plus 60 mesh, and minus 60 mesh. Table XII shows screen analyses.

The solid material in the overflow of the 10-ft. cones is principally fine silica.

Feed is conditioned for tabling as it is dewatered or is thickened to the proper density. The tanks and cones have functioned satisfactorily in classifying and conditioning the feed for table work, and have required practically no attention.

The spigot discharge of the 4-ft. sand tanks goes to an eight-way splitter and then to eight coarse sand tables, where tailing, middling, and concentrate are made. That of the 6-ft. tanks goes also to an eight-way splitter and then to

**Flowsheet of concentration unit, Scrub Oak mill. This also shows the manner of disposing of products and of recovering water.**



### Table X—Tons of Feed and Products in Magnetic Circuit, Scrub Oak Mill

Three-part Separation in Two Stages

| Separators | Long Tons Per Hour: Feed | Final Tailing | Rougher Concentrate | Middling for Recrushing | Final Concentrate |
|---|---|---|---|---|---|
| Primary roughers | 90.00 | 41.92 | 48.08 | ..... | ..... |
| Primary finishers | 48.08 | ..... | ..... | 24.04 | 24.04 |
| Secondary roughers | 24.04 | 8.24 | 15.80 | ..... | ..... |
| Secondary finishers | 15.80 | ..... | ..... | 7.90 | 7.90 |
| Second pass to secondaries | 7.90 | 4.04 | ..... | ..... | 3.86 |
| Final products | | 54.20 | | | 35.80 |

### Table XI—Percentage of Magnetic Iron in Items Shown in Table X

Percentage Iron

| Separators | Feed | Final Tailing | Rougher Concentrate | Middling for Recrushing | Final Concentrate |
|---|---|---|---|---|---|
| Primary roughers | 24.60 | 1.20 | 45.00 | ..... | ..... |
| Primary finishers | 45.00 | ..... | ..... | 30.00 | 60.03 |
| Secondary roughers | 30.00 | 1.20 | 45.00 | ..... | ..... |
| Secondary finishers | 45.00 | ..... | ..... | 30.00 | 60.03 |
| Second pass to secondaries | 30.00 | 1.20 | ..... | ..... | 60.03 |
| Final analysis | | 1.20 | | | 60.03 |

### Table IX—Screen Analysis of Finished Product of Crusher Plant

| Mesh | Weight, per Cent | Mesh | Weight, per Cent |
|---|---|---|---|
| — 6 + 8 | 2.00 | — 48 + 100 | 16.67 |
| — 8 + 10 | 9.83 | — 100 + 200 | 9.17 |
| — 10 + 28 | 33.50 | — 200 | 8.83 |
| — 28 + 48 | 20.00 | Total | 100.00 |

eight medium sand tables, which make tailing, middling, and concentrate. The spigot discharge of the three 10-ft. cones goes to a four-way splitter and then to four fine-sand tables, where tailing and concentrate are made.

Tailing from all tables is delivered to a 16-in. flat drag conveyor and sent to the tailing dewatering drag. All concentrate from tables is combined with that from the magnetic separators. Middling from the coarse and medium sand tables is joined to that from the finisher separators and sent to the rod mill. Thus the secondary magnetic separators and the coarse and medium sand tables are in closed circuit with the rod mill. Rod mill product must be removed from the circuit either as secondary magnetic separator concentrate or as table tailing or concentrate.

Table XIII shows the performance of the rod mill when crushing middling from minus 6 to minus 20 mesh in closed circuit, as described. The mill has a peripheral discharge consisting of thirty 1½-in. round openings lined with rubber, through which 98 per cent of the feed is discharged. The remaining 2 per cent passes through the trunnion. Mill speed is 15 r.p.m. and rod size 1 to 3 in. The mill is driven by a 100-hp. motor through a Tex-rope drive. Only half of this power is used, however, as the mill is loaded only to 50 per cent of its capacity, the rod load being about 10,000 lb.

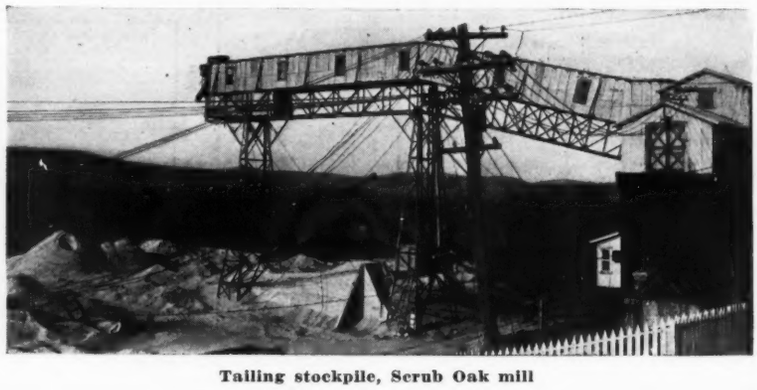
The rod mill feed amounts to 40 dry tons per hour with a dilution of 3 to 1. Of this the new feed totals 30 tons, consisting of 24.04 tons from the primary finisher separators and 6 tons of table middling. From the secondary finisher separators 7.9 tons of middling is repassed to the rod mill and 2 tons of table middling, an approximate total of 10 tons per hour on the second pass. The amount of material returning on the third pass is so small that it can be disregarded.

Power provisions for this section are as follows: The six screw feeders, the twenty magnetic separators, and the twenty tables are driven from line shafts, which, in turn, are driven by a 50-hp. motor. The flat drag conveyor that delivers middling to the rod mill is driven by the dewatering drag motor. No. 8 Wilfley pump is driven by a 100-hp. motor and No. 4 Wilfley pump by a 30-hp. motor.

Table XIV shows the present rate of feed, in dry tons per hour, for each magnetic separator or table in the mill.

Direct current for excitation of magnet is furnished by a motor-generator set, governed by a Tirrill voltage regulator. Power provisions for the section are as follows: Including the rod-mill motor and the motor that drives the motor-generator set, there are five motors in this section with a total of 310 hp., or 3.44 hp. per ton of crude ore treated. More horsepower installed for driving the magnetic separators and for excitation of magnets is 50, or 0.56 hp. per ton of crude ore treated.

The manner of handling concentrate and tailing and recovering water is also shown in the flowsheet. Concentrate from the magnetic separators and the tables is delivered by a drag conveyor to a 5x20-ft. dewatering drag. The latter is inclined at 35 deg. with blades set every 24 in. on double No. 132 Hercules manganese chain. Teeth or rakes are attached to the blades and keep the bed of concentrate, about 1 ft. deep on the tank bottom, well raked, so that water readily sinks into it and flows back to the overflow at the lower end of the tank. Concentrate containing about 10 per cent moisture is discharged at the top of the tank.

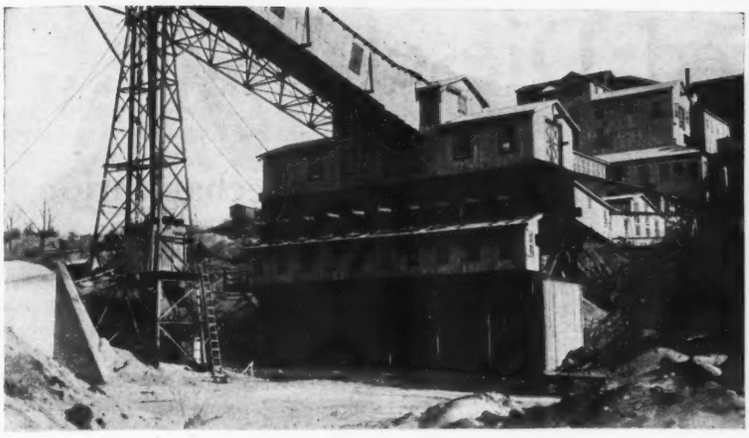


Tailing stockpile, Scrub Oak mill

The overflow carries fine iron with it and is pumped by a 2-in. Morris pump to a 10-ft. Allen cone, where the iron is discharged through the spigot and returned to the drag. Cone overflow goes to the thickener. Concentrate is discharged by the dewatering drag on to a 16-in. conveyer, which in turn delivers to a second 16-in. conveyor and thence to a 1,000-ton shipping bin at the rail-

### Table XII—Screen Analyses of Products of Classification of Table Feed

| Screen Mesh | Spigot 4-Ft. Sand Tanks. Weight, per Cent | Spigot 6-Ft. Sand Tanks. Weight, per Cent | Spigot 10-Ft. Cones. Weight, per Cent | 10-Ft. Cone Overflow. Weight, per Cent |
|---|---|---|---|---|
| — 6 + 8 | 3.10 | .... | .... | .... |
| — 8 + 10 | 11.25 | 0.50 | .... | .... |
| — 10 + 14 | 11.50 | 0.75 | .... | .... |
| — 14 + 20 | 12.25 | 1.25 | .... | .... |
| — 20 + 28 | 14.00 | 3.25 | .... | 0.10 |
| — 28 + 48 | 26.90 | 20.25 | 0.09 | 0.10 |
| — 48 + 65 | 12.80 | 22.10 | 3.10 | 0.50 |
| — 65 + 100 | 3.25 | 25.50 | 15.00 | 2.00 |
| — 100 + 150 | 2.30 | 18.50 | 7.50 | 2.60 |
| — 150 + 200 | 1.00 | 5.00 | 7.50 | 3.10 |
| — 200 | 1.00 | 2.50 | 66.80 | 91.20 |
| | 99.35 | 99.60 | 99.99 | 99.60 |



**Concentrate bin, Scrub Oak mill**

road tracks. It is weighed by a Telepoise conveyor scale and distributed in the bin by a Stephens-Adamson shuttle conveyor.

Table tailing is gathered by a 16-in. flat drag conveyor and delivered to a dewatering drag, similar to that handling the concentrate. The overflow of this drag is also settled in an Allen cone, the spigot discharge returning to the tailing conveyor and the cone overflow going to the thickener. Two 16-in. conveyors take the dewatered tailing to the stockpile. Tailing is weighed before stocking by a Merrick Weightometer.

The three flat drag conveyors, the two dewatering drags, and the two 16-in. conveyors, as well as the 2-in. Morris pump, are driven by a 40-hp. motor. Both the concentrate conveyor and the shuttle conveyor are driven by a 15-hp. motor, the tailing conveyor is operated by a 25-hp. motor, and tailing reclaiming conveyor by a 10-hp. motor. The thickener is driven by a 5-hp. motor, the sludge pump by a 20-hp. motor, and the reclaimed water pump by a 200-hp. motor.

The overflow of the three 10-ft. cones used for classifying the table feed is sent to a 60-ft. Dorr thickener; likewise that of the 10-ft. cones used for settling the drag overflows. Thickener sludge is pumped to waste by a 2-in. Morris variable-speed pump. Thickener overflow goes to a 30,000-gal. settling tank and thence by a 6-in. Morris pump to the mill supply tanks.

Fifteen hundred gallons of water per minute is used in the mill, and of this amount 80 per cent is recovered. Three hundred gallons per minute is added as make-up water.

The total connected motor load for this unit is 315 hp. Average is 3.5 hp. per ton of crude ore treated for handling mill products and recovering water.

Table XV shows the screen-assay of concentrate produced. Average grade of concentrate, as shipped, is 60.03 per cent iron. The table shows that the coarser sizes of concentrate are low in iron, but that the iron content increases sufficiently in the sizes finer than 20 mesh to carry the lower-grade coarser sizes. Curve 1, Fig. 6[2], shows a similar rise in iron content in the finer sizes, which is characteristic of the work of wet-belt separators. The concentrate, on account of the coarser sizes, is an excellent sintering material.

Scrub Oak deslimed sand, as produced from the drag dewaterer, is the only manufactured sand in New Jersey, and has been fully approved by the State Laboratory for use in all types of concrete. It is the basic sand product, from which other specially sized sands are produced. The tailing from the mill, containing about 10 per cent moisture, is conveyed directly to the main stockpile, under which a concrete tunnel, housing a reclaiming conveyor, is located. (A. H. Hubbell: "Crushed Stone and Concrete Sands from Mine Waste and Mill Tailing," *E.&M.J.*, Vol. 132, p. 526, 1931.)

Erection of a screening plant and a set of bins, spanning the railroad, is planned. To this plant can be diverted from the stocking conveyor such material as is necessary to take care of immediate deliveries of concrete sand and furnish the material from which to screen the special sizes. Surplus concrete sand goes to the main stockpile, where it can be reclaimed whenever production falls below demand.

[2]"Evolution of Magnetic Milling at Scrub Oak." *E. & M. J.*, June, 1933.

**Table XIII—Rod Mill Performance on Scrub Oak Ore**

(Crushing Middling From Minus 6 to Minus 20 Mesh)

| Mesh | Feed Weight, per Cent | Peripheral Discharge Weight, per Cent | Trunnion Discharge Weight, per Cent |
|---|---|---|---|
| — 6 + 8.... | 6.00 | .... | .... |
| — 8 + 10.... | 19.00 | 0.50 | .... |
| — 10 + 14.... | 15.50 | 2.50 | .... |
| — 14 + 20.... | 11.00 | 3.00 | .... |
| — 20 + 28.... | 13.50 | 20.00 | .... |
| — 28 + 48.... | 16.00 | 38.50 | 0.25 |
| — 48 + 65.... | 8.50 | 14.00 | 1.50 |
| — 65 + 100.... | 5.00 | 10.00 | 19.00 |
| — 100 + 150.... | 2.50 | 4.00 | 38.25 |
| — 150 + 200.... | 1.50 | 2.00 | 22.00 |
| — 200..... | 1.50 | 5.50 | 19.00 |
| | 100.00 | 100.00 | 100.00 |

**Table XIV—Rate of Feed to Each Separator or Table**

Long Tons Per Hour

| | | | |
|---|---|---|---|
| Primary roughers | 15.0 | Coarse sand tables | 4.2 |
| Primary finishers | 8.0 | Medium sand tables | 3.2 |
| Secondary roughers | 10.0 | Fine sand tables | 0.9 |
| Secondary finishers | 5.0 | | |

**Table XV—Screen-Assay of Scrub Oak Concentrate**

| Screen Mesh | Weight, per Cent | | Total Iron, per Cent |
|---|---|---|---|
| — 6 + 8..... | 1.33 | | 39.25 |
| — 8 + 9..... | 2.44 | | 40.55 |
| — 9 + 10..... | 3.51 | | 39.90 |
| — 10 + 14..... | 8.04 | | 43.45 |
| — 14 + 20..... | 9.42 | | 51.75 |
| — 20 + 28..... | 11.36 | | 58.85 |
| — 28 + 48..... | 24.17 | | 64.80 |
| — 48 + 65..... | 11.50 | | 66.40 |
| — 65 + 100..... | 10.41 | | 65.15 |
| — 100 + 150..... | 6.73 | | 65.15 |
| — 150 + 200..... | 4.32 | | 67.15 |
| — 200..... | 6.77 | | 69.40 |
| | 100.00 | (Average) | 60.03 |

**Summary of Mill Costs**

Magnetic and Gravity Concentration, January to April, 1930

| | Tons |
|---|---|
| Crude ore treated..... | 118,314 |
| Concentrate produced..... | 54,138 |

| Description | Total |
|---|---|
| General..... | $0.035 |
| Crushing..... | 0.077 |
| Drying..... | 0.007 |
| Screening..... | 0.027 |
| Magnetic concentration..... | 0.033 |
| Classification..... | 0.006 |
| Wet table concentration..... | 0.016 |
| Dewatering..... | 0.009 |
| Conveying and elevating..... | 0.052 |
| Pumping..... | 0.042 |
| Loading concentrate..... | 0.011 |
| Stock tailing..... | 0.025 |
| Electric power..... | 0.125 |
| Extraordinary repairs..... | 0.020 |
| | $0.485 |

Labor — tons per man per 8-hr. shift, 47.3
Kw.-hr. per ton of crude ore milled, 10.0
Percentage of total power at mine, 56.0

**Summary of Mill Operations**

Iron in crude ore milled
- 24.6 per cent magnetic iron
- 5.4 per cent non-magnetic iron
- 30.0 per cent total iron

Rate of milling, 90 long tons crude ore per hour

Magnetic separation
- Feed, 90 tons per hour crude ore containing 24.6 per cent magnetic iron
- Concentrate, 35.8 tons running 60.03 per cent magnetic iron
- Tailing, 54.2 tons running 1.20 per cent magnetic iron
- Recovery of magnetic iron units, 97.07 per cent
- Ratio of concentration, 2.51 to 1
- In addition to the magnetic iron in the tailing from the magnetic separators, 8.97 per cent of non-magnetic iron was also present, bringing the total iron in the tailing to 10.17 per cent.

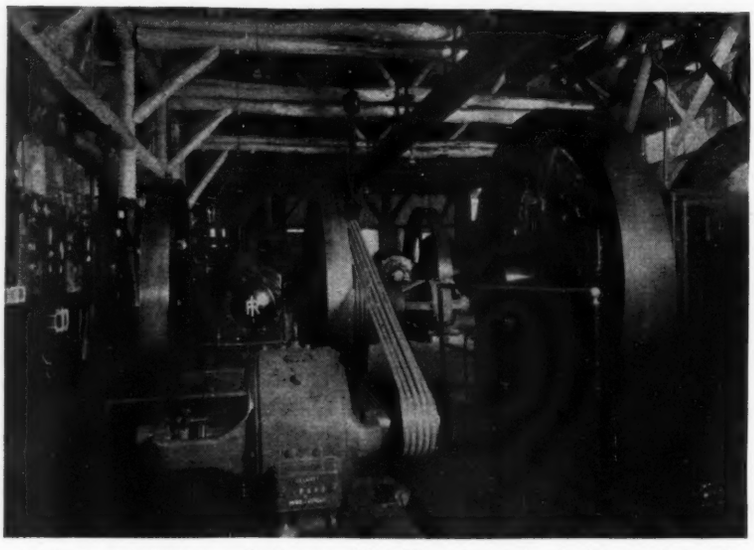
Tabling
- Feed, 54.2 tons separator tailing per hour, containing 10.17 per cent total iron
- Concentrate, 5.3 tons containing 60.03 per cent iron
- Tailing, 48.9 tons containing 4.75 per cent iron
- Recovery of total iron units, 57.86 per cent
- Ratio of concentration, 10.2 to 1

Total Operation
- Crude ore fed, 90 tons per hour containing 30 per cent total iron
- Concentrate, 41.1 tons per hour containing 60.03 per cent iron
- Tailing, 48.9 tons per hour containing 4.75 per cent iron
- Recovery of iron units, 91.4 per cent
- Ratio of concentration, 2.19 to 1

# An Isolated Diesel Plant

## Remoteness Demanded Simplicity—Objective Mechanization

WHEN a plant is 12,000 miles from the source supplying its machinery and equipment, and nine months are required to secure a repair part, the executive in charge may count himself fortunate if simplicity of operation and maintenance has been the objective of its designer. Realizing the importance of such considerations, the Mutual Chemical Company, of New York, wisely allowed itself to be guided by them when the time came for building a power plant needed to mechanize operations at its chrome-ore mines in New Caledonia. The manager in charge of these properties is Enoch Perkins. R. G. Bergman is general superintendent, and H. M. Blanchard, master mechanic, is in direct charge of the power plant to be described, and is responsible for its operation and maintenance.



**End view of 23-kw. unit No. 1, with 70-kw. generator in the background. Diesel-driven compressor is seen at right.**

New Caledonia, the second largest island in the South Seas, lies east of Australia, 750 miles off the Queensland coast and 1,077 miles from Sydney. It belongs to France, and has been a consistent producer of chrome and nickel ore since 1886. The company has four mining properties, two of which have been opened up to date. These are Alpha mine, at Paggoumene, and the Fantoche, at Nehoue, the latter being the principal one. The workings of each reach to more than 1,000 ft. in depth. The labor includes the native Melanesians, French Tonkinese, Javanese from the Dutch East Indies, and Japanese. Foremen and power-house operators are French of local origin.

Before the power plant was installed, all mining was done by hand. In time, however, the desire for greater production and lower costs led to a study of the possibilities of machine mining, using the labor supply available. Whether or not these men could be taught to run drills was an open question. They had shown they were capable of handling locomotives and launches and those of the better sort were proving themselves able hand miners—a promising indication. The decision to install air drills was therefore made. In this way the problem of power supply was introduced.

Determination of the kind of power to be used was simple. Neither electricity nor water power was available. Coal was high-priced, having to be brought from Australia at a cost of $14 per ton laid down at the mine. Although the cost of fuel oil was also high, diesel engines were attractive because of the opportunities they offered for low-cost operation, ease of handling and maintenance, and simplicity of plant layout and design. Diesel power was therefore decided upon.

Design of the plant was undertaken with an eye to the conditions cited. Machinery parts had to be limited in weight to a maximum of 4 tons, to permit transshipment in the coastal steamers and because the bridges on the company's railroad to the mine would not carry a heavier load. Furthermore, the power-house site selected was well up a hillside, which also made it advisable to limit weights to a convenient amount.

Current was to be used for hoisting, pumping, lighting, auxiliary ventilation, machine-shop operation, and other lesser purposes. Equipment selected for the power house was as follows:

1 110-hp. diesel-driven direct-connected compressor.

1 110-hp., 70-kw. diesel-driven generator.

2 35-hp. 23-kw. diesel-driven generators.

2 small gasoline-driven starting units.

2 centrifugal pumps for circulating cooling water.

The four diesel units are all of the same type and are of Carels-Ingersoll-Rand make. Save for the difference in size of flywheels, the two 110-hp. engines are alike and, except in horsepower, flywheel size, and speed, are the same as the two 35-hp. units. All are shown in the illustration.

More specifically, the two 110-hp. semi-diesel units are Type POC2 horizontal, solid-injection, cold-starting, 4-cycle, single-acting, heavy-duty oil engines, 17x19 in. in cylinder dimensions and built to run at 260 r.p.m. Of these, the compressor engine is direct-connected through a flying wristpin to the compressor, which is a two-stage intercooled, horizontal unit, 16½x13¼x19 in. in dimensions and of a piston-displacement capacity of 608 cu.ft. Features of this installation are that the means employed for direct-connection entail no loss in power and that two-stage compression, unusual in so small a unit, is used.

The other 110-hp. unit, which drives a 70-kw. generator, is connected with the latter by a Tex-rope drive having eight 13¼x¾x100-in. ropes. Similar drives connect two 35-hp. diesel units with their respective generators, save that there are five ropes instead of eight. These engines run at 350 r.p.m.

### Operation Economical

For medium-size installations, the four-cycle oil engine of this type is said to outdo any other kind of prime mover in operating economy. Adoption of the cold-starting, solid-injection principle,

moreover, has made starting easy and safe and has rendered unnecessary the accessory high-pressure compressor required by the full diesel engine.

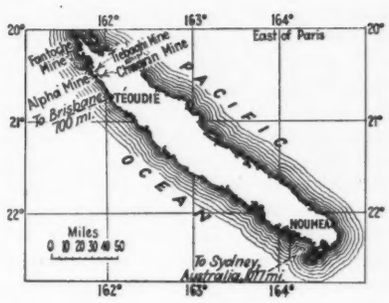
To aid in starting, when needed, the two gasoline-engine-driven starting units provided deliver air at 200 lb. to three bottles. However, the latter are ordinarily charged with the burned gases from the engines through a water-cooled check valve, so that the starting units are required only after a shut-down of several days.

Fuel oil burned comes from Balakpapan, New Guinea. Under the conditions it is expensive, costing 3.35 francs (the rate of exchange being 3.92c. per franc) per British Imperial gallon, delivered at the power house. The fuel oil guarantee is 0.43 lb., per brake horsepower, of an oil of 19,350 B.t.u. value at continuous full load; 0.43 lb. at three-quarter load, and 0.46 lb. at half load. Interestingly, the actual consumption compares favorably with that of much larger units on equal load factor. When running loaded, which is roughly 56 per cent of the time, the compressor engine consumes 2.7 gal. per hour. The engine driving the 70-kw. generator, also operating on a 55 per cent load factor, burns 2.91 gal. per hour, generating 12.75 kw.-hr. per British Imperial gallon of oil. The two engines driving the 23-kw. generators (only one of which runs at a time) take 0.93 gal. per hour on a 0.4 load factor, generating 9.78 kw.-hr. per gallon. Consumption in both is close to the manufacturer's guarantee for the stated load factors.

### Fuel Oil Trans-shipped

The fuel oil is brought by the Shell Company in bulk to Noumea, where it is pumped into 50-gal. drums and shipped to the mine wharf on the coastal steamer and then transported 2¾ miles on the mine narrow-gage railway to the fuel-oil pump house. Here it is dumped into a steel sump, from which it is pumped 2,000 ft. against a 180-ft. head to a 1,000-gal. storage tank, located well away from the power house at an elevation sufficient to allow gravity flow. The line has suitable water traps. In the power house are 30-gal. calibrated day tanks for each engine. Valves for shutting off the oil are provided in the power house and at several points on the line.

Cost of lubricating oil is also high, being 35 francs per gallon, delivered at the plant. Vacuum DTE Extra Heavy oil is used in the engines and DTE Heavy Medium in the compressor. The engine manufacturer guarantees a consumption not to exceed 1 British Imperial gallon per 24-hr. operation in case of 110-hp. engines and 58 hr. per gallon for the 35-hp. units. Consumption in the compressor end is twelve drops a minute for the entire cylinder, so that the air-compressor lubrication cost is negligible. About 70 per cent of the oil is reclaimed, unchanged in quality save as to color. This is done in batches, the oil being heated, washed with water, the heavy solids settled out and removed and the rest purified centrifugally.




**Noumea is the chief port of New Caledonia**

Cooling water is taken mainly from the mine; but if necessary or desirable it may be obtained from a creek. The mine water is laundered to the hot wells, where it joins the engine overflow and then is pumped intermittently to a supply tank 65 ft. above the floor by a 300-g.p.m. Cameron centrifugal driven from the compressor. A similar spare pump is direct-connected to a 20-hp., 250-volt motor. Electrically operated alarms, made by the Bristol Gauge Company, protect the engines against water shortage, high cooling-water temperatures, and low lubricating oil pressure. They are controlled by instruments making a continuous 24-hr. record, which serves more as a check on the men than on the power plant.

The four engines, being single-cylinder, horizontal units, and Tex-rope driven rather than direct-connected, are simple to operate. With respect to maintenance, Mr. Perkins declares that any average mechanic, whether a diesel engine man, so-called or not, will be able to keep the plant running satisfactorily if he will follow manufacturer's instructions. Repairs have been remarkably low. The cylinder liner in the compressor engine was changed after every 23,000 hours of operation, and even then could have run much longer if necessary.

Regarding the air compressor and the three generators, little has thus far been said. The compressor was originally designed to handle five DCR 23 drills (recently supplanted by the S-49) and occasional air hoists and air pumps, if necessary. A reasonable diversity factor was expected, so this unit with a capacity of 608 cu.ft. piston displacement was selected. It runs 19 hr. per day, six days per week.

The large generator is a General Electric Model 21-G d.c. machine (1,150 r.p.m., 127 amp., 550 volt full load, compound wound, 70 kw., 40 deg. continuous). Compensation is provided for taking off 25 per cent of the unbalanced load.

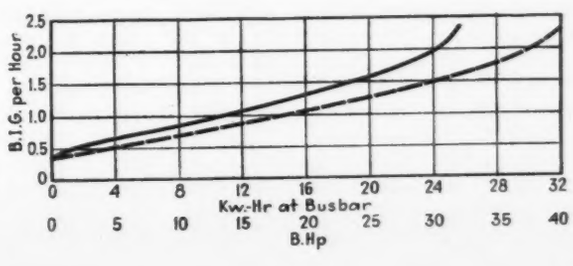
The two 23-kw. machines (Type 3, BISMA, made by Hilliaret, Paris) are rated at 87 amp., d.c., 250-265 volt, compound wound, 1,480 r.p.m. Only one of these runs at a time.

The plant operates on 0.4-0.6 load factor. The 70-kw. generator runs only for pumping or hoisting. Pumping is done 1½ hr. per day and hoisting 4 to 6 hr. daily. One or the other of the 23-kw. units runs 18 hr. a day for 70 per cent of the time. Switching arrangements permit the two to be run either separately or on the same line. In addition, a switchboard is so arranged as to equalize on both legs the greater portion of the 250-volt load, thereby permitting the 70-kw. unit to supply 275 volts for this service, if necessary. All transmission lines are protected with double-pole circuit breakers and lightning arresters. No lines are grounded.

Ordinarily when installing a mine power plant, alternating current generation would usually be preferred for operating purposes. However, to handle such a plant efficiently requires more capable electricians than are necessary when direct current is used. Moreover, by using three-wire generation, the heavy transmission losses, which constitute one of the chief disadvantages of two-wire, d.c. generation, are eliminated. The 70-kw. unit is a three-wire machine generating 500 volts and is equipped with compensation for permitting 25 per cent of balanced load to be taken off at half voltage. This is occasionally done, when one of the 23-kw. machines is not running, in order to serve the 250-volt line.

### Two Feeders for Mine

Two principal feeders enter the mine from the power house, one 500 volts and the other the 250-volt two-conductor line just mentioned. The lights are served by a separate feeder. The 500-volt feeder is a three-conductor lead cable, which is followed by an armored cable in the shaft, which carries the 500-




**Fuel oil consumption of 35-hp. engines. Full line shows British Imperial gallons per kilowatt-hour at bus bar. Broken line shows gallons per brake horsepower.**

volt circuit with a saving of 60 per cent in copper as compared with a two-conductor line. This feeder has a 75-hp. underground hoist and a Cameron pump motor of similar capacity. The 250-volt line serves the small gathering pump, mine lights on the main haulage level, the signal system, and the auxiliary mine fans, as well as small hoists of the scraper type used in the development work, and the machine shop motors and the lights on the surface, including those of the mine village.

For fire protection, a 15,000-gal. concrete-lined storage reservoir is provided at an elevation of 6,500 ft. above the power house. From this, 3-in. lines serve fire hydrants inside and outside the building. Fire hose is 2½-in. standard canvas, with a 1¼-in. nozzle. A wet sprinkler system is installed under the floor and, in addition, a 2-gal. Foamite extinguisher and a 2-gal. Pyrene Minimax are placed at convenient points in the building. The power-house floor is 3 ft. above ground level, and all engine exhaust pipes are at a safe distance from it.

# Advance in Flotation

## Sphalerite and Copper Minerals Separated

*R. E. Barthelemy, the author of the following article, is a consulting specialist in flotation. For several years he was associated with the Peñarroya company, in Sardinia and Spain, where he worked out various problems in flotation. Recently he has been engaged with the Katanga company, which has acquired the rights to his differential process for treating the ores of its Prince Leopold mine. Like most engineers, he has traveled widely. He is a graduate of the École des Mines, of Paris.*

SEPARATION of galena and sphalerite by selective flotation was successfully accomplished by Sheridan and Griswold, who in 1922 introduced cyanide as a depressing agent. The problem of separating sphalerite and copper ores, however, is frequently more difficult, as the latter are usually of a more complex nature. If the copper is present as chalcopyrite only, separation by selective flotation offers no particular difficulty. The case is different, however, when the copper mineral is chalcocite or bornite. Gaudin, discussing this problem, states: "If chalcocite or bornite is present it is very difficult to keep the sphalerite or marmatite from becoming activated and from floating with the copper minerals."

The difficulties encountered may be ascribed to one of the following two causes: Sphalerite formed simultaneously with the copper sulphides, in the center of the deposit, may have been "geoactivated"—that is, activated by hydrothermal action or contact reaction with copper salts formed by chemical action on the copper sulphide. In an ore of this type the zinc mineral would have a natural tendency to float with the copper. Or the reagents added for depressing the zinc—cyanide and zinc sulphate—may react with the copper sulphides in the ore, forming soluble copper salts, which in turn serve to activate the sphalerite.

Experiencing some difficulties in the treatment of ores of this type in Sierra Madrona, Spain, the author, in the early part of 1930, succeeded in finding a solution of the problem, as mentioned in the December, 1930, issue of *Engineering and Mining World*, p. 687. The process, patented in the United States and in several other countries, is being successfully applied in the treatment of the ores from the Prince Leopold mine of Union Minière du Haut-Katanga, which company has secured the rights for the Belgian Congo. Plans for a new mill at this mine are under way.

Collective rather than depressing action is made use of in the process. During the grinding, or during the conditioning prior to the entrance into the flotation machine, the ore is treated with a complex inorganic salt. Dithiophosphate is used as collector, and the sphalerite is floated with no appreciable amount of copper going into the zinc concentrate. After complete removal of the zinc mineral the copper is floated with xanthate as a collector.

A careful study of the mechanism of the process reveals the following points: (*a*) The inorganic salt is adsorbed on the crystals faces of the chalcocite or the bornite, as a colloidal coating which prevents any action by the dithiophosphate. No adsorption takes place on the sphalerite and on the chalcopyrite under normal conditions; under oxidizing conditions, however, chalcopyrite takes on the same colloidal coating. (*b*) Flotation with dithiophosphate or similar collectors, which have no action on the colloid coating on the surface of the copper minerals, would enable the sphalerite to float, while the copper sulphides remain completely deflocculated in the pulp, with no tendency to float. (*c*) After removal of the zinc sulphides, an addition of xanthate removes the colloidal coating, thus permitting flotation of the copper sulphides.

Any condition which tends to increase the stability of the colloidal coating also increases the selective action of the process. Aluminum acetate is particularly beneficial in this respect, whereas the presence of acids or acid salts capable of flocculating the colloidal coating is decidedly harmful. For this reason soluble copper salts should be kept out of the pulp.

The complex inorganic salt used in the process is sometimes adsorbed by the gangue minerals to such an extent that the consumption of this reagent becomes excessive. For that reason it may be necessary to run primary cells with dithiophosphate as collector, and a minimum amount of frothers. The primary concentrate is then treated by the regular process, the sphalerite going into the final concentrate and the copper ore into the tailings. In this procedure the addition of xanthate is not required.

In the primary operation careful attention must be given to the amount of frother used. Pine oil only, in the smallest possible quantity, must be used. Lack of experience in this respect caused some difficulty in Belgian Congo when the process was first introduced. Too much oil was used, with the result that the sulphide particles became coated with oil to such an extent that the inorganic reagent failed to have any action.

In the development of the process tests were made on pure minerals of South American origin. These were carefully ground to minus 200 plus 400 mesh, cleaned on a small laboratory Deister slime table, and finally cleaned with dilute hydrochloric acid. The products thus obtained analyzed as follows: Chalcocite, 77.3 per cent copper; bornite, 61.8; chalcopyrite, 33.1; and sphalerite, 58.4 per cent zinc with no copper.

Adsorption tests to determine the maximum amount of complex salt adsorbed per gram of the various sulphides gave the following results: Chalcocite, 3.83 mg.; bornite, 2.06; chalcopyrite, normal conditions, 0.46, oxidizing conditions, 1.57 mg.; sphalerite, no adsorption under any conditions. The figures indicate a polymolecular film on the faces of the copper minerals.

Sulphides coated in this manner were then treated by different collectors, after convenient cleaning. The film was found to be completely removed by xanthate, whereas dithiophosphate had absolutely no effect. In the light of these results a series of flotation tests was made with mixtures of pure minerals, with the following results:

A chalcocite-sphalerite mixture with 37.7 per cent copper and 23.21 per cent zinc was ground with the inorganic reagent, 1.1 lb. per metric ton, until all of the sample passed through a 150-mesh screen. Flotation after addition of 0.65 lb. sodium Aerofloat and 0.1 lb.

pine oil per metric ton gave a concentrate with 53.4 per cent zinc and 2.74 per cent copper, and a tailing with 6.54 per cent zinc and 58.3 per cent copper. Recovery of zinc in the concentrate was 82 per cent, and of copper in the tailing 97 per cent.

A mixture of equal amounts of sphalerite and bornite was treated in the manner outlined, with a recovery of 77 per cent of the zinc in the concentrate and 89 per cent of the copper in the tailing.

Separation of chalcopyrite and sphalerite gave very poor results under normal conditions. After subjecting the mixture to strongly oxidizing conditions by heating to 325 deg. C., separation was successfully accomplished, with 78 per cent of the zinc in the concentrate and 80 per cent of the copper in the tailing.

Owing to the circumstance that under normal conditions chalcopyrite is not coated by the complex inorganic salt, a separation of chalcopyrite and chalcocite is possible by this method. Test, as outlined, gave a recovery of 89.5 per cent of the chalcopyrite in the concentrate and 96.3 per cent of the chalcocite in the tailing. Similar results were obtained in the separation of bornite from chalcopyrite.

The process was then applied to a complex copper-zinc ore from Coquimbo, Chile, of the following composition: copper, 13.84 per cent; zinc, 16.02; iron, 7.06; and sulphur, 16.30 per cent. Sixty-two per cent of the copper was present as bornite; 10 per cent as chalcocite; 23 per cent as chalcopyrite; and 5 per cent as covellite.

A primary concentrate was made after grinding the ore to 70 per cent minus 200 mesh with the following reagents: soda ash, 1.8 lb. per metric ton; sodium Aerofloat, 0.3; and Yarmor distilled pine oil, 0.12 lb. per ton. The concentrate was then conditioned for five minutes in a high-speed agitator with 0.6 lb. per ton of the inorganic complex salt, under oxidizing conditions, whereupon the pulp was floated with addition of a small amount of sodium Aerofloat (0.05 lb.). A clean concentrate with 58.80 per cent zinc and 4.68 per cent copper was produced, with a tailing containing 43.30 per cent copper and 8.83 per cent zinc. Tailing from the primary cells analyzed 1.01 per cent copper and 1.12 per cent zinc. The resulting recoveries were: 81.2 per cent of the zinc in the concentrate and 88.4 per cent of the copper in the tailing. For a complex ore of this type the results are far better than any that may be obtained by other known methods.

In conclusion, I wish to express my appreciation to Société Minière & Metallurgique de Peñarroya for providing the facilities for the research work; to American Cyanimid Company for supplying the chemicals used during the tests; and to Mr. Loix, of Union Minière de Haut-Katanga, whose wide experience in the field of flotation proved of great value in the introduction of the process in the Belgian Congo.

# Copper Product Perfected

## Anaconda Makes Sound Sheets by Electrolysis

*B. H. Strom*

PRODUCTION of sound metallic sheets by electrodeposition is an accomplishment long desired by copper refiners. Many obstacles have prevented the realization of this attainment, and no commercial production was attempted until the Raritan Copper Works, at Perth Amboy, N. J., put a unit in operation in the summer of 1931. It has been working continuously since that time. The difficulties to be overcome were mainly of a mechanical nature, the difficulty of preserving a smooth stripping surface being the greatest obstacle to success. Five more units have recently been added to the installation, and the plant has a present daily capacity of 6,000 linear feet of copper sheet, 3 ft. wide, and ranging in gage from 0.0017 to 0.013 in., or from 1 to 7 oz. per square foot. One of the units is equipped to make sheets up to 50 in. wide. Sheets of similar thickness cannot be produced in greater widths than 6 in. by rolling. Above 7 oz. per square foot, rolling will probably be the more economic process.

Production of the sheets is accomplished in two steps. In the first operation, involving electrolysis on a revolving cathode, sheets up to 1-oz. thickness are produced. Heavier sizes are made by building up these sheets in a so-called loop cell in which the sheet, entering at one end of the cell, is looped in and out of the solution, over rollers placed successively above and below the soluble copper anodes.

The drum cell, shown in Fig. 1, is a

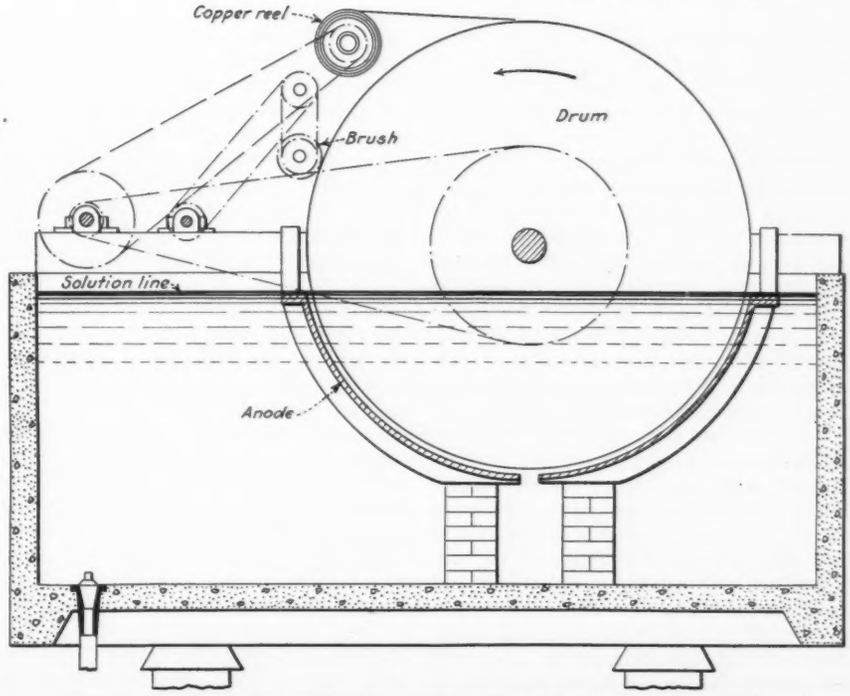



**Fig. 1—Drum cell for production of sheets up to 2 oz. per square foot.**

rectangular lead-lined concrete unit, of the type and size used in regular copper refining. A revolving drum, 66 in. in diameter and 36 in. wide, made of 6 per cent antimonial lead, serves as cathode. Many metals and alloys were tried before a suitable cathode material was found. Some of these would stand up well for a while, but all finally became pitted and produced sheets of inferior qualities. Common antimonial lead, properly treated to give a perfectly smooth surface, was finally found to stand up well when treated with a revolving brush as shown in the sketch. A pair of anodes of the same material, curved to conform with the circular cathode, and spaced at $\frac{3}{4}$ in., are used. As the drum emerges from the cell, the sheet is stripped, washed with a spray of water, and coiled on a reel. By regulation of drum speed and current density any thickness up to 2 oz. may be produced on the drum. With the current density normally used, 140 amp. per square foot, a peripheral drum speed of $9\frac{1}{2}$ in. per minute produces a 1-oz. sheet.

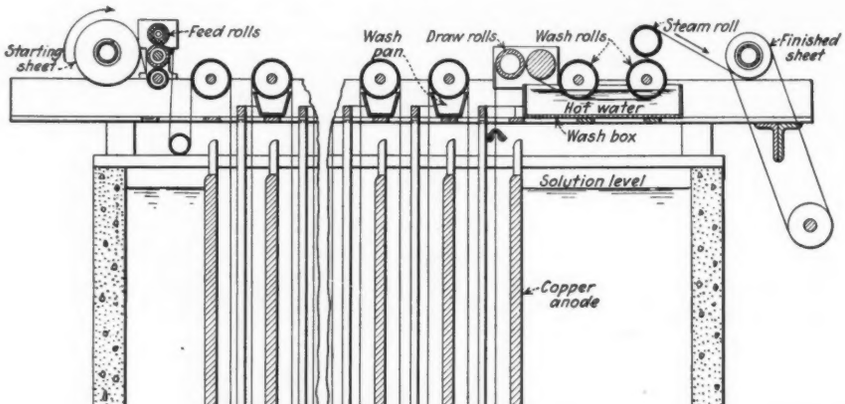



**Fig. 2—Loop cell, in which the thinner sheets are built up to desired thickness.**

On account of the high current density used in this cell the solution must be agitated with air, as the liberated oxygen is not sufficient to prevent stratification of the electrolyte. Air agitation is required when the current density exceeds 60 amp. per square foot. This is the reason why insoluble anodes are used; regular copper anodes, curved to fit the shape of the drum, work equally well, but cannot be used if a high current density is desired to increase the cell capacity, as the air agitation stirs up the anode slime and spoils the deposit.

Regular copper anodes are used in the loop cell, which operates at a current density of 40 amp. per square foot. This cell, which is shown in Fig. 2, is equipped with nine loop frames and ten anodes and has 2-in. spacing between sheet and anode. An important point in its construction is the position of the bottom rolls, which are placed between, not directly under the anodes and about 1 in. above their lower edge. This arrangement prevents a rough deposit caused by the anode slime dropping on the sheet. The rolls are of wood, covered with a layer of vulcanized rubber of fairly hard texture. The top rolls revolve in pans of running water to wash off the solution, which otherwise would evaporate and leave copper sulphate crystals on the roll surface, against the sheets, with the result that the sheets would become rough. As the sheet finally leaves the last frame it is passed through a wiper to remove the bulk of the solution adhering to the surface. It then goes through a pair of draw rolls into a shallow pan of water. Finally, it passes over a steam roll to dry the water and is coiled on a reel. By using underhand coiling on the reel, both sides of the finished sheet may easily be inspected at one glance.

To change anodes the entire looping frame is lifted out with the crane, whereupon anodes and slime may be removed in the usual manner. They are not allowed to remain in the cell until entirely ready to scrap, but are finished in regular scrap sections. This is done to avoid uneven edges on the sheets, resulting from old irregular-worn anodes.

No special electrolyte is used in the process. The feed to the drum cell coming from the main system contains 43-47 grams copper and 180-200 grams free sulphuric acid per liter, with the normal amount of goulac. Cell temperature is kept 124 to 126 deg. F. Cell discharge is returned to the main system. In the loop cells the electrolyte, which also originally comes from the main system, is re-circulated and allowed to build up to 55-60 grams copper per liter, the sulphuric acid concentration being maintained at about 150 grams per liter. A small amount of glue is added in these cells. A higher temperature is also used, about 150 deg. F. Correct concentration is maintained by withdrawing part of the solution when the copper content goes above the desired figure, replacing it with fresh electrolyte. Circulation in the drum cell is about 4 gal. per minute; in the loop cell, 6-8 gal. per minute. In both cells the feed enters at the bottom and overflows at the top.

One motor and two generators are used with the present installation, one of the generators being connected to the drum cells and the loop cells, in series, the other generator serving the loop cells only. This gives 3,000 amp. to the drum cells and 6,000 amp. to the loop cells. A 5-hp. motor takes care of all mechanical requirements in operating the drums and pulling the sheets through the loop cells. The voltage on the loop cells is about 0.8; on the drum cells 2.8 volt. No loss in copper production results from the higher voltage on the latter cells, as they take the place of a corresponding capacity of liberator cells, in the main system. Both cells operate with a current efficiency of about 95 per cent.

Sheets of any length and thickness up to about 7 oz. per square foot may be produced. A day's production of a drum—1,000 ft.—is the length generally used. When a new reel is started in the loop cells, the end of the sheet is welded to the end of the old reel at the head of the cell, an operation taking only a few minutes. The joint is later cut off the finished sheet. The loop cell may also be fed directly from the drum cell. This arrangement is, however, rarely used, as it reduces the flexibility of the system. Current density and speed of looping determine the thickness of the final sheets.

The sheets are perfectly sound and have every appearance of rolled metal; even 1-oz. sheets (0.0017 in. thick), when held up against a lighted bulb in a dark room, give no evidence of perforation. Automatic regulation of current density and drum speed assures a control of tolerance in gage thickness said to be equal to or even better than that obtained in rolling.

The finished reels are uncoiled, trimmed, and cut to proper lengths and widths prior to shipment. Trimming of the edges may later be dispensed with, as experiments conducted at the present time promise to give sheets with perfect edges. Five of the units now in operation produce sheets 36 in. wide. The sixth unit is equipped for making a 50-in. sheet.

I am indebted to Frederick Laist, general metallurgical manager, Anaconda Copper Mining Company, for permission to publish this article.

# Processing Witherite

## . . . An Uncommon Barium Mineral

*H. Conrad Meyer*

WITHERITE (natural barium carbonate) is a relatively rare mineral, generally occurring in pockets along barite veins, though occasionally it is disseminated in small particles through a lode. In the British Isles only three workable veins with witherite as the main constituent are known. Northumberland County has always been the principal producing region, the most important mines being near Hexham. These are all on galena-bearing veins in which the witherite occurs in the form of huge lenses or "swells" rather than in regular veins.

Many of the deposits from which witherite has been obtained in limited quantities in the past were first worked as lead mines by the Romans during their occupation of Britain, beginning about 85 A. D.

With few exceptions, all British witherite is obtained as a byproduct in the mining of galena, sphalerite, and barytes. Where the witherite and barytes occur intimately associated, it is economically impossible to separate them, owing to their almost parallel specific gravities. The presence of any appreciable quantities of barytes, galena, zinc blende, limestone, or pyrite in witherite is highly detrimental to its commercial application. Run-of-mine ore should carry little or no barytes. In fact, the presence of any mineral with a specific gravity close to that of witherite (4.29 to 4.35) makes a high-grade concentrate impossible. It is for this reason that many apparently promising British deposits of witherite, coupled with the pockety and uncertain character of the orebody, have ceased to produce within a comparatively short time after mining operations have been started. In many instances heavy financial losses have been sustained by hasty and ill-advised undertakings of this character.

The ore-dressing procedure of the best-known and principal deposit, Settlingstones Mines, is briefly as follows: The witherite is first hand-picked to remove the cleanest and highest-grade pieces. Some of this ore is of sufficient purity to be sent directly to the market, as it runs from 94 to 98 per cent barium carbonate. The lower grade, carrying from 60 to 70 per cent barium carbonate, is crushed to pass a 1-in. screen and then concentrated in a series of specially designed jigs, which in one pass sort the material into two grades: plus 4 mesh, about 93 per cent barium carbonate; and minus 4 mesh, about 83-84 per cent barium carbonate. In recent years, through improved mining methods, the minus 4-mesh concentrate has been raised to 90 per cent barium carbonate or better. Ore running about 40 per cent barium carbonate is concentrated in a somewhat different and more costly manner. Such material, before it is jigged, is passed through a jaw crusher, five sizing trommels, and two sets of rolls. All of the material passed through the jigs is minus 4 mesh. This operation yields a product running about 83 per cent barium carbonate. By blending the jigged concentrates with high-grade lump, a standard 92-94 per cent grade can be produced. A typical analysis of a standard concentrate follows: Barium carbonate, 91.25 per cent; calcium carbonate, 1.60 per cent; magnesium carbonate, 0.30 per cent; barium sulphate, 4.10 per cent; ferric oxide, 0.25 per cent; alumina, 0.50 per cent; silica, 1.15 per cent; carbonaceous material, 0.55 per cent.

**Wall, in vicinity of Settlingstones mine, built by the Romans about 100 A.D.**

**Roman ruins near the witherite mines**

The vein is almost vertical and has an average width of about ten feet. The richest ore is between the 480-ft. and the 800-ft. levels, and mining is confined to this horizon. Unlike many British mines, the methods at Settlingstones, both of mining and concentrating, have been completely modernized by the installation of the most up-to-date equipment and the adoption of the best practice. This mine has a potential output of from 10,000 to 15,000 tons per annum for, at least, thirty to forty years.

Being a carbonate, witherite lends itself to chemical treatment more readily and economically than the only other commercial source of barium—namely, barite. It is readily decomposed by all mineral acids and many of the organic acids, with the formation of the corresponding salt. The barium oxide content of a standard witherite concentrate is close to 75 per cent, as against a barium oxide content of only 65 per cent in barite, the sulphate. Furthermore, the preparation of barium products from barite involves the conversion of the inert and refractory sulphate to

**Working face, 500-ft. level, Settlingstones witherite mine**

the sulphide by expensive furnacing operations. The sulphide is then converted into artificial or precipitated carbonate, from which point the preparation of other barium compounds is much the same as if witherite were used as the basic raw material. Unfortunately, the demands for barium compounds are so far in excess of available witherite supplies that the industry is compelled to use barite, which is abundant and commands a somewhat lower price than the natural carbonate.

The natural carbonate appears on the market in three forms: first, as lumps or smalls; second, as a coarsely ground product; and third, as an air-floated, impalpable powder. Normally, the consumption of coarsely ground or air-floated carbonate in the United States is much greater than lumps or smalls. The Foote Mineral Company, as the only American importer and grinder of witherite in recent times, has developed over a period of years a closed-circuit method of milling or grinding at the company's Philadelphia plant, which produces a minus 325-mesh powder. It has been demonstrated in certain industries that the efficiency of natural barium carbonate is directly proportionate to the fineness of the particles, and such fineness can be economically secured only by carefully controlled air-flotation.

The witherite ore as it is discharged from the cars at the Foote company's plant is carried by a monorail system to a large rotary oil-fired dryer. After passing through the dryer, which reduces the moisture content to practically nil, the witherite is reduced to $\frac{3}{4}$ in. by a duplex jaw crusher. It is then conveyed by steel-cased bucket elevators to a large ball-race mill, which reduces it to a fineness of about 80 per cent through 200 mesh. This comparatively fine powder is then classified by an air separator, which in one operation separates the plus 200-mesh particles from the minus 200-mesh particles. The former are returned automatically to the ball-race mill for regrinding. The impalpable or minus 200-mesh product, the major part of which will pass a 325-mesh screen, is discharged into a stock bin, from which it is packed in multiwall paper bags holding 100 lb.

Normal commercial demands for natural barium carbonate are, in about the order of their importance, as follows: case-hardening, sugar refining, heavy clay products, enameled iron ware, barium peroxide, water and brine purification, barium chemicals, and in the manufacture of glass.

# Gold Blankets Used in Bussieres Mill

THE Bussieres mill of Treadwell Yukon, in Quebec, Canada, which started experimentally in September, 1932, treated at first only rock from development headings, according to a report by P. R. Bradley, consulting engineer to the company. As mine development and preparatory work progressed, the quantity increased and the grade has improved from $1.57 per ton in October, 1932, to $5.02 per ton in February, 1933.

The milling process is as follows: Mine-run ore is screened, washed, and sorted; primary crushing by a jaw crusher is followed by roll grinding in closed circuit to produce a satisfactory ball-mill feed. Ball-mill discharge is passed over blankets, thence to a Dorr classifier, the oversize from which returns to the ball mill, the undersize passing to a second series of blankets, and thence to waste. The blanket concentrate, amounting to 0.5 per cent by weight of the mill feed, is treated in an amalgam barrel for the recovery of free gold. Tailing from this treatment is stored at present, but ultimately a form of re-treatment will be provided. The extraction of the mill feed based on gold in the blanket concentrate is 80 per cent. Additional recovery will be made by passing the blanket tailing to flotation; experimental work shows that the tailing loss can be reduced to 20c. per ton milled. Flotation concentrate will be treated by cyanidation, along with the tailing from the amalgam barrel.

Development work being done is limited by the capacity of the steam-driven and electric-driven air compressors. The amount of ore milled has been limited by the capacity of the original steam-driven hoist. This has just been replaced by a larger and better steam hoist, and milling operations will be stepped up to the capacity of the one ball mill now installed—150 tons per day. Additional development work to open up more stoping areas will give greater control of grade, and by Oct. 1, 1933, the property should be self-sustaining.

Plans are being considered for increasing the output of power from the hydro-electric plant; this can be about doubled. When this new installation is completed, additional milling capacity and additional compressed-air equipment will be installed for increasing the milling capacity to 300 tons per day, which will mean breaking 900 tons per day in the mine.

■

# Continuous Lead Refining

## Costs Cut at Port Pirie—Products Improved

IN THE NEW REFINERY of Broken Hill Associated Smelters Proprietary, Ltd., at Port Pirie, South Australia, practice differs from that of the former plant in that each of several steps of refining successively for arsenic and antimony, copper and gold, then silver and finally for zinc, is conducted continuously instead of by the batch method previously used. A brief description of this plant was given in *Engineering and Mining Journal*, April, 1933, pages 142-4. Development of the continuous practice is described by G. K. Williams in a paper just published by the Australasian Institute of Mining and Metallurgy, the substance of which is here presented. Early experimentation concerned itself only with the development of a continuous desilverizing process, which in addition to continuous treatment embraces the novel feature of conjugate solution formation with consequent yield of a silver product relatively high in silver and low in lead. The fact that this continuous process would become less attractive were it placed between two batch processes led to further research, resulting in the development of continuous processes for refining for arsenic, antimony and zinc.

### The Batch Plant

Before the introduction of continuous methods, the plant had eight refining units, each comprising an antimony softening furnace, two desilverizing kettles, a zinc refining furnace, and a market lead pan (copper had been previously removed from the bullion). Five of these sets produced 62 long tons of market lead per 24 hr., and three 92 tons, in the same time. Each set had a maximum capacity of two charges of market lead per 24 hr. With all units in operation the plant could produce 560 tons of market lead per day. To increase the refinery's capacity, either more units had to be added or the time of each treatment shortened.

The new refinery with one furnace of each section in operation can produce 560 tons of market lead per day; and with one additional silver kettle in commission, 1,000 tons per day.

Investigation of the degolding and desilverizing processes had been started in 1920 because so little theoretically was known about them. Study of the Parkes process, it was hoped, would result in the evolution of some modification of the method of desilverizing, whereby the time of treatment would be decreased; the silver grade of the crusts produced for retorting would be improved; and the correct quantity of zinc for each charge ascertained.

**Bullion Composition at Port Pirie**

| | Batch Process | Continuous Process |
|---|---|---|
| Softened Bullion | | |
| Arsenic, per cent... | 0.01 | Less than 0.0005 |
| Antimony, per cent | 0.21 | 0.03 |
| Degolded Bullion | | |
| Gold, grains per ton | 6.4 | 0.4 |
| Desilvered Lead | | |
| Silver, oz. per ton.. | 0.19 | 0.03 |
| Zinc, per cent..... | 0.55 | 0.56 |
| Refined Lead | | |
| Zinc, per cent..... | 0.00041 | 0.00023 |
| Antimony, per cent | 0.00557 | 0.00170 |
| Silver Alloy | | |
| Zinc, per cent..... | 15 | 64 |
| Silver, oz. per ton.. | 2,000 | 6,000 |

Start was made by determining and plotting on a right-angled triangular diagram certain of the liquidus curves and eutectics of the Pb-Zn-Ag ternary system, the various mixtures obtained during the desilverization of a pure silver-bearing bullion being ternary mixtures of lead, silver, and zinc. A study of this diagram made it possible to determine the interdependence of certain variables met in desilverizing; to devise other desilverizing methods; to determine the correct quantity of zinc required for each particular method; and to devise a process for enriching the silver crusts produced.

The most suitable method of desilverizing, to be operated in conjunction with the enrichment process, was determined to be the one already in use at Port Pirie. Savings were made in the respective costs of the zinc used in desilverizing and of retorting the silver crusts and cupelling the silver retort bullion, but the time required for desilverizing remained the same. Therefore, if an increase in refinery capacity were required, additional or larger units would be needed.

### Interdependent Variables

Investigation was made of the Port Pirie batch desilverizing process (in which the crusts from a second zincking are used in the first zincking of the next charge and only virgin zinc is used for the second zincking of each charge). The right-angled triangular diagram made it possible to ascertain the interdependence of the following variables: Silver content of bullion before desilverizing; the silver and zinc contents of the bullion after first zincking; silver content after second zincking; temperature of stirring for each zincking (sufficiently high with this process to insure a homogeneous liquid system during stirring); silver content of the crusts produced for retorting; and quantity of zinc required for desilverizing. The interdependence of the variables can be thus determined for any other method of desilverizing.

Of these variables, the only ones under direct operating control are the temperature of stirring for each zincking and the quantity of zinc added to each charge, the former being dependent on the silver content of the bullion before desilverizing and the quantity of zinc added per charge, which should be enough to insure a homogeneous liquid during stirring; and the latter being dependent on the silver content of the bullion before desilverizing and that required afterward, and on the desilverizing method. Thus, in operating the Parkes process the correct amount of zinc for each charge must be known.

### Alternative Methods

Two alternative batch desilverizing processes, A and B respectively, each requiring only one zincking, were considered. In each, the bullion is cooled to solidification and all crusts are removed. In A, the total crusts separating during cooling are removed for recovery of their silver. In B, the total crusts are removed, but only those which separate while the cooling bullion is represented by the upper portion of the liquidus curve (distant from and not adjacent to the eutectic curve) are treated to recover their silver. The crusts separating subsequently—i.e., after this "demarcation" temperature is reached—are returned to the next charge. Method A, compared with the Port Pirie batch method, takes less time for desilverizing, but has disadvantages which exclude it. Method B also takes less time for desilverizing and gives richer crusts for subsequent treatment. Its disadvantages have disappeared since the completion of the development of the crust-enrichment process, explained as follows:

### Crust Enrichment

In the Port Pirie practice, complete liquefaction of the Parkes crusts cannot be secured, owing to the presence of zinc oxide in them, but sufficient liquefaction is obtained to increase the silver in the retort bullion from 2,000 oz. per ton (with no enrichment) to 16,000 oz. (with enrichment). Complete

liquefaction can be obtained by adding ammonium chloride, zinc chloride, or common salt during enrichment, with the result that a retort bullion carrying 25,000 oz. silver per ton can be made. This enrichment process, patented, has been in satisfactory operation at Port Pirie since 1923. It is really Method B, in which bullion containing 2,000 oz. of silver per ton is desilverized.

This modification of Method B embracing conjugate solution formation was first thought to be of little practical interest, owing to the high temperature (600-650 deg. C.). However, certain development in the practical operation of the enrichment process, which made it semi-continuous, provided a new viewpoint. This involved use of a narrow, deep kettle having an inverted siphon pipe, only the upper part of the kettle being heated. Crusts were fed at the top, and the bullion separating from the melt passed downward through the cooler zone to the bottom, whence it was siphoned out. As the bullion passed through the cool lower portion, its zinc and silver separated out in low-grade crusts, which rose into the upper hot section and were again remelted. This suggested the possibility of developing Method B so as to give continuous desilverization without the disadvantages of Method B arising from the greater quantity of crusts to be skimmed and returned to the next charge, and from the greater strain on the workmen who press the crusts, caused by the high temperature.

Three modifications of Method B are available for continuous desilverization: (*a*) Bullion plus the proper amount of zinc is fed continuously into the heated upper section of the kettle, where two liquid layers of conjugate solutions are maintained; the upper solution, or alloy, remains in the upper section, and the lower solution, or bullion, gradually passes downward to the siphon. (*b*) Similar to process just described, save that the temperature maintained in the upper section is not sufficient to liquefy the system, so that conjugate solutions are not formed. (*c*) Identical with (*a*), save that zinc is added intermittently to keep a constant volume of alloy in the upper section. This makes zincking tables unnecessary, as compared with (*a*). During desilverization, the silver content of the alloy increases up to a certain point, when it is dipped from the kettle and replaced with a layer of zinc. Thus the compositions of alloy and bottom solutions are not constant, as they are in (*a*). Zinc required can be determined. The silver grade of the alloy removed controls the maximum temperature required in the upper section and the maximum silver content of the desilverized lead. It is independent of the silver grade of the bullion to be desilverized.

The second continuous conjugate solution process, referred to in the foregoing as (*c*), has been accepted as the most economical modification to operate and will be known as the continuous desilverizing process.

## Degolding

Zinc shows a preferential tendency to alloy with gold and copper as compared with silver. If a limited quantity be dissolved in a bullion containing copper, gold, and silver, and the bullion be allowed to cool, the alloy separating will be proportionately higher in copper and gold than in silver. At Port Pirie, refining for copper (the softened bullion contains 0.05-.07 per cent) precedes refining for silver, the gold going with the copper. Owing to the value of the gold, this is called degolding.

The continuous conjugate solution processes, (*a*) and (*c*) in the foregoing, could be developed to remove copper and gold efficiently from bullion. However, practically, the high temperature of about 850 deg. C., which would be necessary in order to liquefy the top solution (Cu-Au-Zn alloy), would make their operation in a kettle expensive.

The continuous desilverizing process (*b*) can be operated over a large range of temperatures and has been developed to operate satisfactorily with a demarcation temperature of 500 deg. C. In the future this is to be known as the continuous degolding process.

## Continuous Softening and Refining

Continuous treatment, it was appreciated, would obviate time losses arising in the batch process when filling and emptying the softening furnace. Also, by continuously removing the liquid dross through an overflow notch, it was hoped that the losses arising in the batch process from cooling the furnace to solidify the dross, and from skimming, would be eliminated. The earliest work proved that bullion rich in arsenic and antimony could be passed continuously at a high rate through a reverberatory and overflow at the far end consistently low in them.

Although batch zinc refining had been more efficient than other batch processes in the old refinery, time was lost due to emptying, filling, and skimming. Continuous refining has given encouraging results, although it has not yet reached the stage of the other processes. Future development will be concerned principally with determining the optimum size of furnace.

## Advantages of Continuous Work

With continuous processes it is comparatively easy to maintain the principal variables within a small range of their optimum value (see graph), whereas with batch processes only a limited time is available for attaining such optimum values, and it is difficult to insure that such values are attained with each charge. Again, in many cases of batch treatment the optimum value for some of the variables can be maintained only during the latter stages.

The high metallurgical efficiencies of the continuous processes are reflected in the composition of the bullion produced, as shown in Table I.

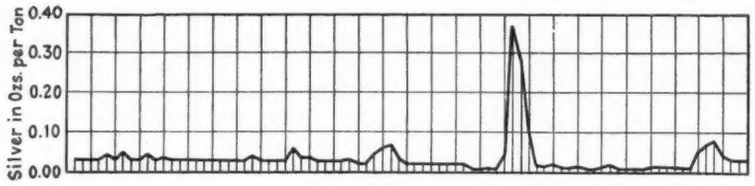
The main variations that can occur during continuous treatment in a particular furnace have to do with the regular flow of bullion and temperature. Irregularities in flow would arise from failure of pumps and launders, against which precautions are taken. Little difficulty is had in keeping temperature within a narrow range of that desired.

Treatment rate of a softening or zinc-refining furnace is greatly increased when the process is operated continuously. This is reflected in the fact that the new refinery covers an area only 48 per cent of that covered by the old. It is also reflected in costs of fuel, labor, and maintenance. With Port Pirie prices for oil (used in new refinery) and coal (old refinery), the cost of total fuel for the continuous processes is only 75 per cent of that for the batch processes. Total labor required for a production of 3,000 tons of market lead per week is 0.504 man-hours per long ton for continuous processes and 2.753 for batch.

Much smaller units are required in softening and zinc refining by the continuous processes, so maintenance costs would naturally be lower. The degolding and desilverizing sections have not been running long enough to permit a statement. For the new refinery as a whole an improvement of about 40 per cent in maintenance costs is indicated.

In continuous desilverizing, no zinc tables are required.

Continuous operation affords flexibility as to varying treatment time rates. Fuel, labor, and maintenance costs per 24 hr. are approximately constant, being governed by size of units and more or less independent of the treatment rate. For successful application, the units must therefore be of the correct size.




**Graph giving silver content of desilverized lead, produced by the continuous process.**

# World's Longest Bi-Cable Ropeway

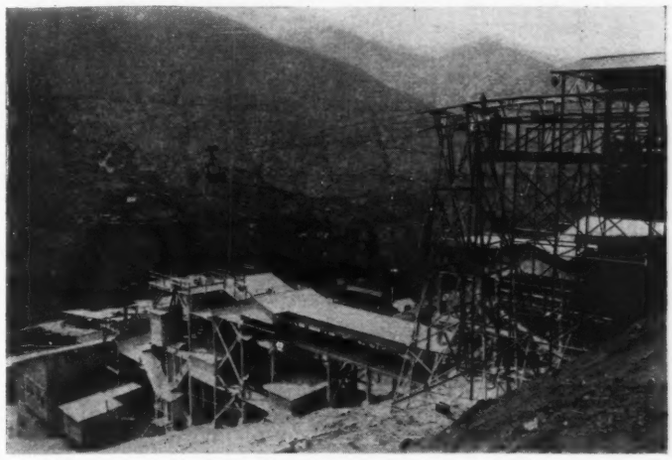
*Wylie L. Graham*

IN 1927 a bi-cable, high-speed, continuous rope tramway, 30 miles long, was put in operation by the Northern Peru Mining & Smelting Company. Design, erection, and management of the unit were entrusted to T. H. Graham & Sons, and the manufacture of the equipment to the Riblet Tramway Company, of Spokane, Wash.

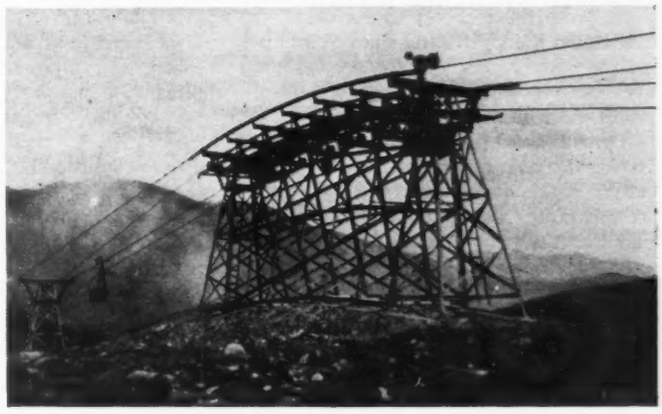
Properties of the Northern Peru company, a subsidiary of American Smelting & Refining, include all the Callacuyan coal mines in the district of Quiruvilca, province of Santiago de Chuco, about 50 miles from the Trujillo railway. These mines form the terminus of the ropeway, at an elevation of 13,176 ft. The first loading, transfer, and control station on the line is at Quiruvilca, the site of the Diana group of mines, formerly owned by the Sociedad Minera Quiruvilca, producing copper, gold, and silver. At 5.86 miles from the terminus are the discharge stations at Shorey, where a smelter and mill went into operation in 1927, which produced as much as one million pounds of copper per month in 1928. During 1929 a sintering plant was added, increasing capacity of the unit. Between Shorey and the mines at Milluachaqui, a distance of 18.461 miles, are two control and transfer stations. At Milluachaqui gold and silver ore is loaded, for treatment at the Samne mill, 6.4 miles distant. The total length of the tramway is therefore 30.79 miles. Elevations above sea level vary from 13,176 feet at Callacuyan to 4,680 ft. at the Samne mill. The steepest incline is 35 deg.; the longest span, or distance from steel to steel, 4,351 ft.; the highest span, or vertical distance from ground to rope track, 1,400 ft.

Rope speed varies from 500 to 550 ft. per minute, giving a capacity between the Samne-Shorey sections of 15 tons per hour; between the Shorey-Quiruvilca section of 50 tons per hour; and in the Quiruvilca-Callacuyan section of 12.5 tons per hour. The system has 4 terminals, 3 transfer freight stations, 4 control stations, 2 angle stations, 5 rail stations, 40 tension stations, and 308 towers. Material transported includes copper ores and fluxes, silver and gold ores, coal, quartzite, lime rock, blister copper, timber, oil, coke, scrap tin, pig iron, brick, cement, dynamite, rails, pipe, steel plates, structural steel, oxygen, steel balls, gasoline, foodstuffs, and general supplies. The total length of wire rope in use totals 124 miles. Traction ropes are of $\frac{3}{4}$-in. plow steel, lang lay, 6x7. Track ropes are of (1) 1-in. diameter plow steel, smooth coil, 37 wires; (2) $1\frac{1}{8}$-in. diameter plow steel, smooth coil, 37 wires; (3) $1\frac{1}{4}$-in. diameter crucible steel, full-lock coil; and (4) $1\frac{3}{8}$-in. diameter crucible steel full-lock coil.

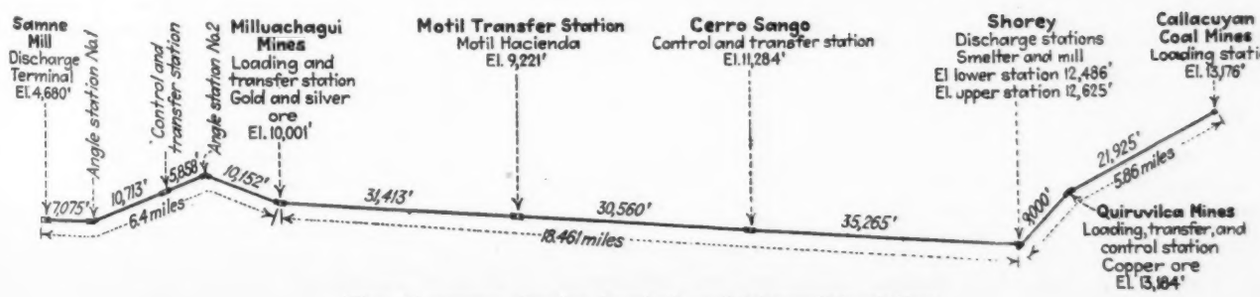
Motors for starting and running total 10, rated at 510 hp. Those for running



**One of the ropeway terminals**



**An angle station along the tramway**




**Plan of ropeway showing terminals and intermediate stations**

only total 7, rated at 410 hp. Details follow:

*Samne-Milluachaqui Section:*

Corrales Control Station—One 75-hp. G.E. induction motor, direct-connected to a Falk 8 HA herringbone reducer-gear unit, single reduction. Ratio 6.93 to 1. Guaranteed capacity for continuous operation, 84 hp., with 100 per cent excess capacity for starting and momentary overloads.

Milluachaqui Control Station — Duplicate of the unit at Corrales.

*Milluachaqui-Shorey Section:*

Milluachaqui Control Station—One 20-hp. G.E. slip-ring induction motor for starting. Back gear, ratio 6.5 to 1; belt connected to pinion shaft having a jaw clutch. One 40-hp. G.E. slip-ring induction motor for running, belt connected to pinion shaft having jaw clutch.

Cerro Sango Double-Control Station—Two 40-hp., G.E. slip-ring induction starting motors. Back gear, ratio 6.2 to 1. Belt connected with pinion shaft having jaw clutch. Two 75-hp. G.E. slip-ring induction running motors. Belts connected to pinion shafts having jaw clutches.

*Shore-Callacuyan Section:*

Quiruvilca Control Station, Shorey section—One 30 hp. Westinghouse slip-ring induction motor. Back gear, ratio 4 to 1; belt connected to pinion shaft.

Callacuyan Section — One 40-hp. G.E. slip-ring induction motor. Back gear, ratio 4 to 1. Belt connected to pinion shaft.

The number of Peruvian laborers engaged employed on the tramway system averaged about 140, involving a monthly payroll of about $3,500. Details of tonnage handled, miles transported, and per ton per mile cost are given in the accompanying table.

| | Average Metric Tons per Month | Average Ton-Miles per Month | Cost per Ton-Mile, Cents |
|---|---|---|---|
| 1927..... | 26,262 | 122,679 | 12.38 |
| 1928..... | 32,912 | 160,911 | 11.85 |
| 1929..... | 32,462 | 179,808 | 10.08 |
| 1930..... | 27,084 | 120,484 | 9.31 |
| 1931..... | 25,075 | 117,962 | 7.40 |
| Average..... | 28,759 | 140,369 | 10.20 |

# Between Compressor and Face

## Distributing Air Underground

### *Lucien Eaton*

PIPES for delivering compressed air two classes: (a) main lines; (b) underground may be divided into branches. By "main lines" are meant lines permanently installed or moved only at long intervals. "Branches" are those lines subject to more frequent moving. In the first category come the pipes from the receiver to the shaft, the line down the shaft, and the larger lines on the main levels. In the second class are lines in raises and stopes, on sublevels, and in development headings.

The pressure in compressed-air lines is not high enough to require extra-strong pipe. Standard pipe can be used. In the larger sizes considerable saving can sometimes be made, in places where transportation is expensive, by using well-casing, which is lighter than standard pipe, or spiral-riveted pipe, still lighter. To economize by using pipe that is too small is a mistake. Sharp and unnecessary bends, especially in main lines, should be avoided. Globe valves should also be avoided on the main lines, as they cause large friction losses. Gate valves should be used instead. If possible, losses in pressure due to friction should be kept down to 10 lb. per square inch or less, and should be divided as evenly as practicable between main lines and branches, including air hoses. Line-pressure at the drill should be tested every 3 to 6 mos.

Minimum sizes of pipes and their frictional losses are shown in Table I.

The air line on surface, extending from receiver to shaft, is sometimes buried or carried in a concrete or brick-lined tunnel. Better practice is to place it above the surface and to support it on piers. If standard fittings are used, flanges should be inserted at every second or third joint, with tees at intervals where a connection may be wanted.

If the pipe is buried, Dresser couplings (Fig. 1A) may be used. They permit a slight amount of bending and allow movement lengthwise. For this reason, the pipe should be buried or bolted to piers, lest it blow out.

A coupling much favored in recent years is the Victaulic coupling, Fig. 1B. In it a split collar is bolted over the pipe ends and holds a specially designed rubber gasket. In the United States a groove of the same depth as standard pipe threads is cut around the pipe near the end, and in it the edge of the collar fits loosely, and thereby holds the ends of the pipes together. In England, on the light standard pipe, which has thinner walls than in the United States, a narrow collar rolled on the pipe end serves the same purpose. These couplings are easily put on, and permit a slight amount of bending. They are most frequently used on pipe over 1½ in.

For the main line down the shaft standard pipe with extra heavy flanges or Victaulic couplings should be used, when the diameter exceeds 4 in. With smaller pipe Victaulic couplings or standard fittings may be used. In the latter circumstance, a malleable union having a brass seat, or a pair of malleable flanges, should be inserted at every second or third joint. A tee, preferably one with a branch of a fairly large radius, should be used at every level; likewise a gate-valve at the shaft collar and on the branch at each level.

Size of pipe used on each main level should be determined by the maximum flow of air it is likely to carry during the life of the level, and should be large enough to keep the pressure loss due to friction within predetermined limits. With the same pressure the volume delivered varies as the square root of the fifth power of pipe diameter. Velocities should be under 25 ft. per second.

If standard connections are used, a pair of flanges or a union is desirable at every third joint. Tees should be inserted, when the pipe is laid, at all points where a branch may be needed. In a dry mine the pipe may be laid on the drift floor at the side, but in a wet mine, especially where the water is corrosive, it should be hung from the walls. In timbered drifts it can be attached to the posts, and in untimbered drifts it can be suspended from hook bolts inserted in short drill holes and held in place by outside wedges. Small chain, ⅜-in. galvanized wire strand, or No. 9 car wire, may be used for hanging it.

Size of branch lines should also be proportioned to the flow of air they may be expected to carry. Having a shorter life in one position than the main lines, a heavier frictional loss is

**Table I—Sizes of Pipes**

| Air Compressor Capacity in Cu.Ft. of Free Air Per Min. | Size of Pipe, Diameter in Inches | Friction Loss Per 1,000 Ft. in Lb. per Sq.In. 80 lb. | 100 lb. |
|---|---|---|---|
| 500 | 4 | 0.85 | 0.68 |
| 1,000 | 5 | 1.04 | 0.88 |
| 1,500 | 6 | 0.95 | 0.78 |
| 2,000 | 6 | 1.69 | 1.41 |
| 2,500 | 6 | 2.64 | 2.14 |
| 3,000 | 8 | 0.87 | 0.76 |
| 3,500 | 8 | 1.19 | 0.98 |
| 4,000 | 8 | 1.55 | 1.30 |
| 5,000 | 10 | 0.77 | 0.63 |

Friction losses in pipes are given in much greater detail on pp. 74 and 75 in the 1927 edition of "Compressed Air Data," published by the *Compressed Air Magazine*, and on p. 125 of Peele's "Mining Engineer's Handbook," 1927 edition.

justified and relatively smaller pipe may be used. Table III is empirical, based on experience, and is a useful guide.

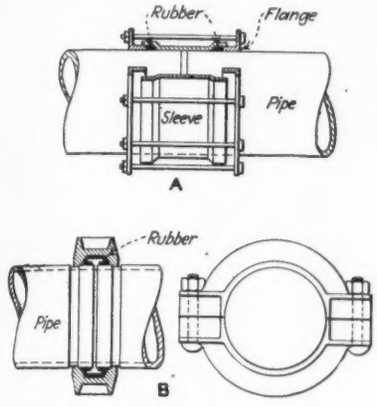



**Fig. 1 — Joining pipe. *A*, Dresser coupling. *B*, Victaulic coupling.**

Use of smaller than 2-in. pipe is seldom advisable, except for the 100 or 200 ft. nearest the drill, and 2-in. line should be kept as close to the breast as blasting will permit. Pressure loss due to friction when drilling amounts to more than 1 lb. per square inch for every 100 ft. of 1-in. pipe or hose, so these should be kept as short as feasible. Near the breast, where pipe must be removed at every blast, unions with brass seats should be used.

As to the kind of valve that is best for air lines, opinion differs greatly. Decision on the matter is usually a compromise between price and quality, and the latitude of choice is great. Since service underground is severe, breakage is as important an item as wear, and consequently expensive valves generally may be eliminated; and globe valves, also, on account of their high frictional loss, are not to be recommended except in small sizes. Under most conditions iron-bodied gate valves with brass or bronze valves and seats and non-rising stems are most suitable for pipes 3 in. or more in diameter. For pipes larger than 4 in. the valves should be flanged rather than screwed. On pipes 2½ in. or less in diameter stopcocks are usually satisfactory. Those with an iron body and a brass plug are best in the 2-in. and 2½-in. sizes, and in the smaller sizes all-iron stopcocks with the plug or cone reversed are preferable.

## Metering Air

In detecting leaks and determining the amount of air used on different levels or in different sections air meters are useful. They cause a slight drop in pressure, but the possible economies may offset this loss many times. Leaks may seem unimportant, but they work 24 hr. a day and impose a heavy load on the compressor. Valves left open after blasting are a common and serious cause of waste.

The most efficient meters are those based on the Venturi tube principle, but

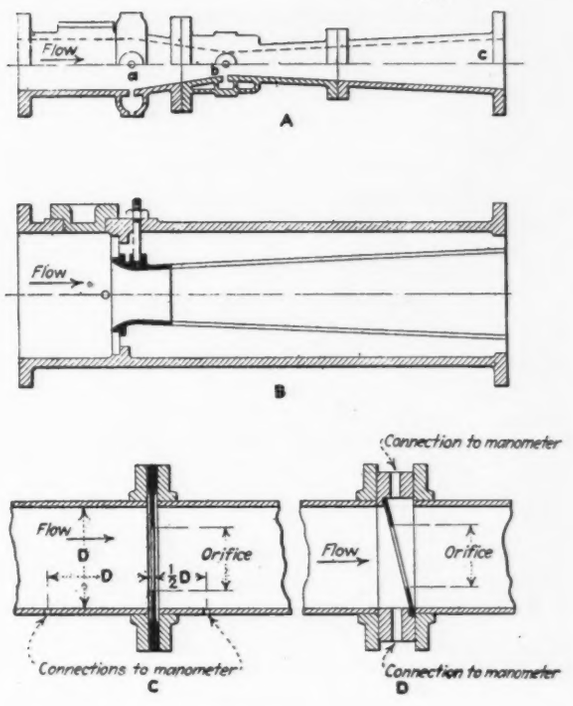



**Fig. 2 — Metering air. *A*, Venturi meter. *B*, Orivent meter. *C*, and *D*, orifice meters.**

they are the most expensive. An outline drawing of one is shown in Fig. 2A. The difference in pressure between the point *a* and the throat *b* depends on the velocity of flow, and is integrated by the recording gear to show the volume of air passing through at normal temperature and pressure.

The Orivent tube shown in Fig. 2B operates on much the same principle as the Venturi meter, and is smaller and less expensive, but causes a slightly higher loss in pressure. These meters are used for smaller branches.

On branch lines meters of the orifice type, examples of which are shown in Fig. 2 C and D, are used. Connection is made from each side of the orifice to a manometer, essentially a U-tube partly filled with liquid. These meters are less accurate than those of the Venturi type, but are comparatively inexpensive.

Meters of the turbine type are fairly accurate, but are not suitable for use with reciprocating compressors, because of the pulsations of the air current. A gate-type meter is operated by these pulsations, and is said to be fairly accurate. It is used in measuring the air consumption of rock drills inside and outside the cylinder.

A direct-reading air meter that gives good results is shown in Fig. 3. It depends for its operation on the friction of the air passing through perforations in the wall of a vertical cylinder in which there is a piston supported by the current of air. By its weight the piston determines the difference in pressure.

**Table II—Table of Pipe Sizes**

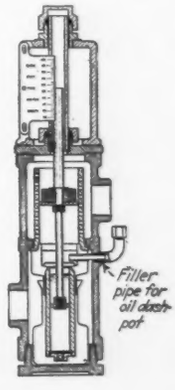
| Volume of Free Air Cu.Ft. per Min. | Length of Pipe Feet | Diameter of Pipe Inches |
|---|---|---|
| 500 | 500 | 3 |
| | 1,000 | 3½ |
| 1,000 | 500 | 4 |
| | 1,000 | 4½ |
| | 1,500 | 5 |
| 1,500 | 500 | 4½ |
| | 1,000 | 5 |
| | 1,500 | 6 |
| | 2,000 | 6 |
| 2,000 | 500 | 5 |
| | 1,000 | 6 |
| | 2,000 | 7 |
| 3,000 | 500 | 6 |
| | 1,000 | 7 |
| | 2,000 | 8 |
| 4,000 | 1,000 | 8 |
| | 2,000 | 8 |

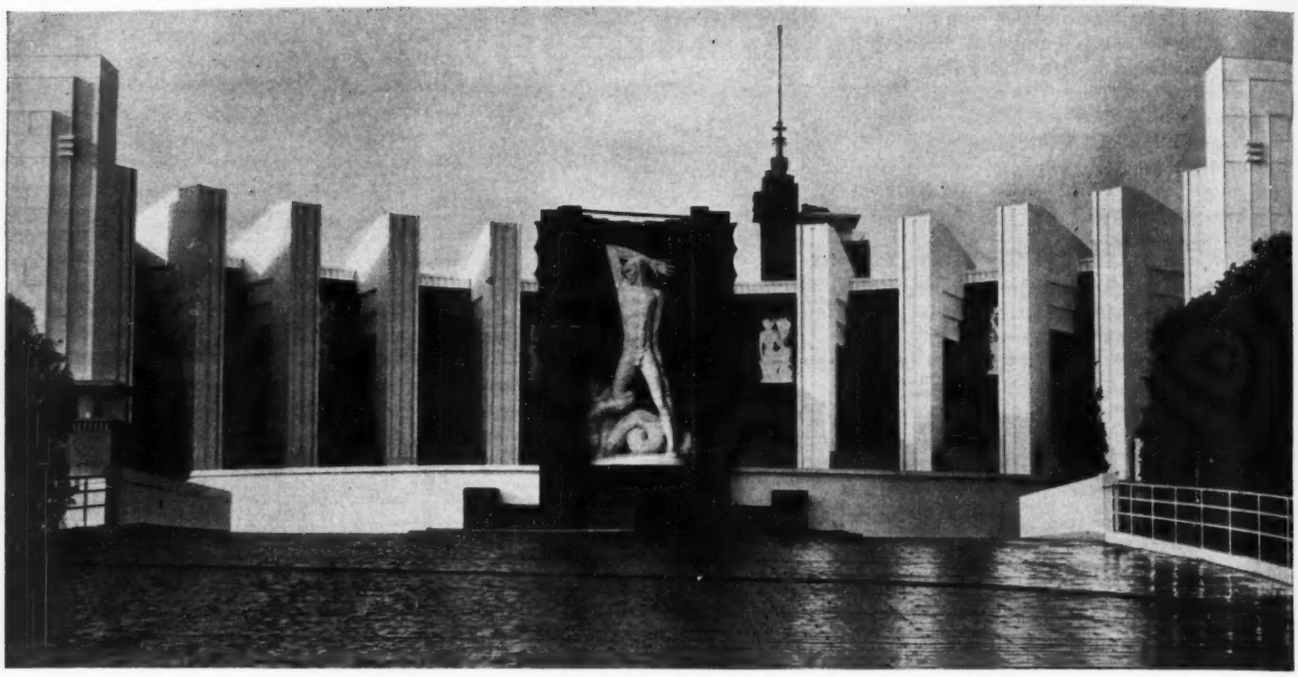
Although half-inch sizes, for example 3½ in., are given, these should be avoided, and the next larger size of pipe should be used. Very little 5-in. and 7-in pipe is seen about mines.

**Table III—Size of Branch Lines**

| Diameter of Pipe, Inches | Number of Drills | Maximum Length of Pipe Feet |
|---|---|---|
| 1½ | 1 | 400 |
| 2 | 1 | 1,500 |
| | 2 | 500 |
| | 3 | 250 |
| 2½ | 2 | 2,000 |
| | 3 | 500 |
| | 4 | 200 |
| 3 | 3 | 2,500 |
| | 4 | 1,500 |
| | 5 | 500 |
| | 6 | 250 |
| 4 | 6 | 2,500 |
| | 7 | 1,500 |
| | 8 | 1,000 |
| | 10 | 700 |
| | 12 | 500 |
| 5 | 12 | 2,500 |
| | 15 | 1,200 |
| | 20 | 600 |

**Fig. 3 — Volumetric direct-reading air meter.**





*Decorative entrance to Hall of Science done in dark blue and white*

# *A Century of Progress*

## Chicago Fair Features the Contributions of Science and Engineering to Human Welfare

*H. C. Parmelee*

WHEN YOU VISIT the exposition on Chicago's lake front you will be pardoned if memory immediately recalls your first glimpse of a kaleidoscope, with its geometrical patterns in bright and striking colors. The impression will be intensified at night, because in its exterior aspects the characteristic features of the Century of Progress are lighting, color and architecture. The combination is distinctly modern, bold in conception and startling in effect.

Lighting plays an essential part because the huge buildings are windowless, and display of the exhibits within depends on artificial light. But night lighting is equally important to reveal the colored walls of the modernistic structures. This is accomplished by a form of flood lighting specially designed for the exposition, in which screened sources of light illuminate the colored façade of the exhibit buildings. Thousands of feet of gaseous tube lights—neon and mereury vapor—are used to produce novel decorative effects and to outline parts of the buildings. Grounds and roadways are lighted by a variety of forms of lighting standards appropriate to the architecture and landscaping.

But it is the lavish use of color as well as light that gives the exposition its claim to architectural distinction both by day and by night. Every color of the spectrum is used in striking combinations on large areas, and, inasmuch as color is an integral part of the buildings, it is necessary to use only white light at night to bring out the structural beauty. The photographic reproduction of the illuminated Hall of Science, shown herewith, gives an idea of the lighting, but it is wholly inadequate to convey the blue of the carillon tower or the red of the extensive façades. Nor can one appreciate in a photograph of the entrance of the Hall of Science, shown above, the deep blue of the darker areas in contrast with the solid white of the figures. One must see the stadium-like Transportation Building, the long low building devoted to Agriculture, and the geometric forms of the General Exhibits Buildings in color to sense the new note that has been struck in architecture.

The theme of the exposition is science. Consequently the exhibits illustrate the fundamental laws and basic principles of the sciences and their engineering applications. Invention and discovery have characterized our century and have molded the industrial civilization in which we live. Hence it is appropriate to portray the progress that has been made and the influence it has had on human welfare.

Mining as an industry is not adequately portrayed at the fair. Nevertheless the exhibits hold for the mining engineer or metallurgist an absorbing interest that will well repay a visit. His breadth of training in the basic sciences and in other branches of engineering enlarges the scope of his appreciation beyond that of the average visitor, and enables him to spend his time profitably. The Hall of Science, the Electrical Building, the General Exhibits Building, and the Transportation Building will hold his major interest. But considering the oft-expressed wish of many a mining engineer to spend his retiring days on a farm, the group of buildings devoted to agriculture will stimulate his imagination and whet his desire.

The principles of geophysical prospecting are exceptionally well portrayed in the Hall of Science by a combination of charts and structural exhibits prepared at the Colorado School of Mines. And although the exhibits apply particularly to oil, they illustrate the location of mineral deposits by surface measurement of physical quantities that are affected by structural arrangement of sub-surface bodies. Four structural exhibits illustrate the use of methods involving sound wave speed, density, magnetism and electrical conductivity.

Others show the mapping of oil structures by explosion waves, using small electric lights to picture the time interval between the firing of the shot at one point and the arrival at another of the waves traveling through the surface or reflected from sub-surface strata. Still others illustrate the variation of induced electrical field on faulted formation, variation of magnetic attraction on granite ridge, variation of electrical resistivity on anticline, and variation of pendulum oscillation on anticline.

Geologists will be interested in a deformable stream table which the attendant can adjust to show the erosional and depositional factors that influence the earth's surface. By changing the pitch of the table and the flow of water a variety of terrains can be produced. At another point a huge Clock of the Ages ticks off 2 billion years of geological time at the rate of 10 million years per tick, while appropriate illustrations are flashed on a screen and a phonographic voice describes conditions existing in the various ages.

### Ultra-violet Light Reveals Mineral Characteristics

Fluorescence of certain minerals under ultra-violet light is shown with a magnificent group of specimens of willemite, wernerite, fluorite, sphalerite and others. At successive intervals the specimens are illuminated alternately by incandescent and ultra-violet lamps, the latter bringing out the striking color characteristics of the minerals.

Dioramas have been used throughout the exposition with unusual success to portray all kinds of industrial operations. These exhibits are combinations of working models and physical objects in the foreground, merging insensibly into painted backgrounds that lend an air of distance to the scene. In this manner Texas Gulf Sulphur Co. shows the recovery of sulphur by the Frasch process, with glass-tube air-lifts working in a vertical section of the geological structure. Surface models of powerhouse, railroad, steam shovels and blocks of sulphur complete an educational exhibit of exceptional value. In like manner, one sees the mining of phosphate rock in Florida.

Directly interesting to mining men is the exhibit of the Denver Equipment Co., which is demonstrating the flotation process of mineral recovery. The machines are laboratory models of commercial units, but in operation they illustrate the principles and give the results of milling practice. A gold-lead-zinc ore, previously crushed to ¼ in., is fed from a bin to a ball mill and thence to a Fahrenwald unit flotation cell where concentration of the gold is effected. The concentrate passes to a Wilfley table.

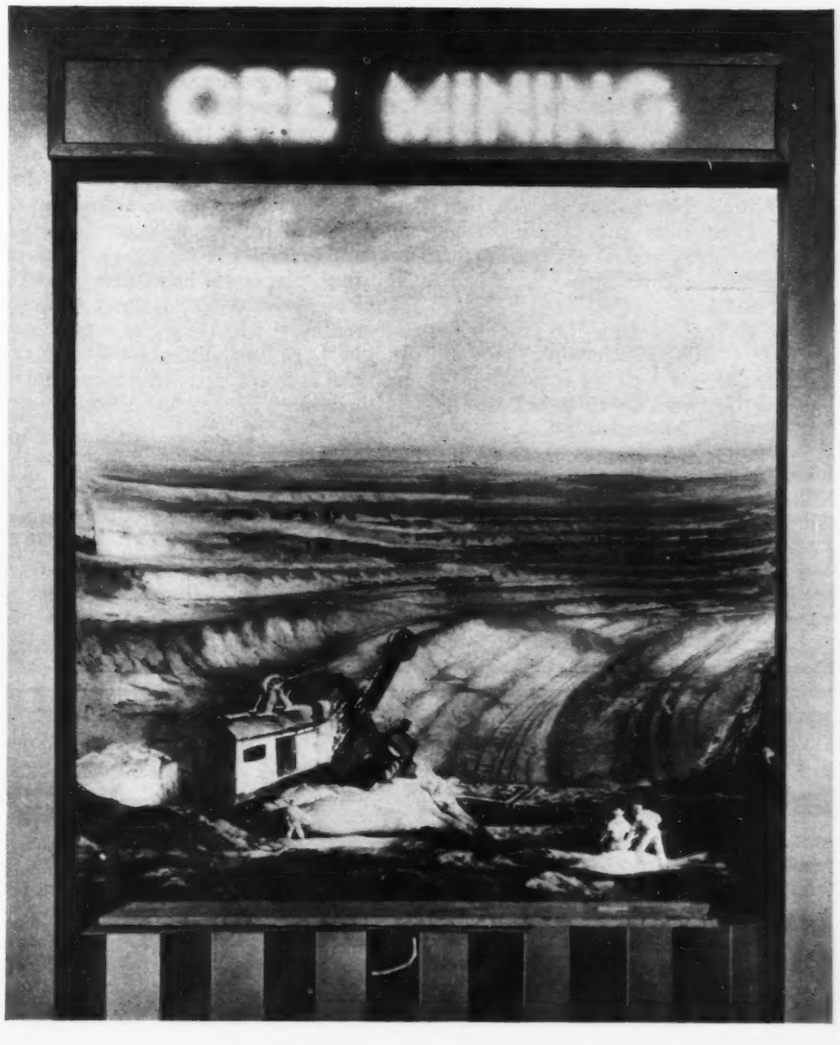
### Flotation Process Demonstrated

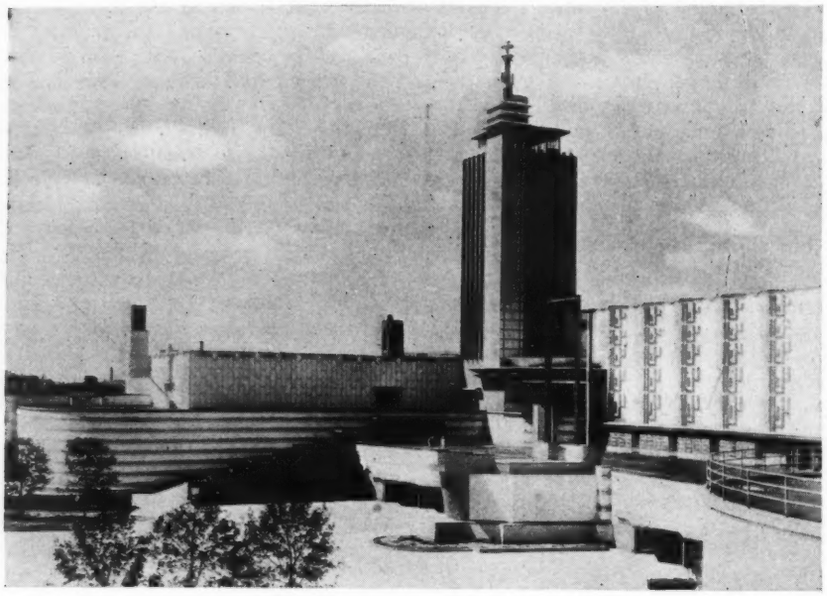
Tailings from the flotation cell are classified and the fine material is conditioned for further flotation of lead and zinc minerals. This is demonstrated in a series of flotation cells for each mineral. Finally the concentrates are filtered. In addition to this exhibit in action, the company is showing the Denver mechanical gold pan for recovering placer gold by mechanical methods. The machine simulates the action of hand panning but treats a much larger tonnage than is possible by hand methods.

Electrometallurgical processes and ferro-alloys form the central part of the Union Carbide exhibit. Gas welding and cutting are demonstrated, and liquid air experiments are performed and explained. A few experiments are repeated automatically, such as the manufacture of calcium carbide and the melting of iron by the electric arc. Models of carborundum and arc furnaces give a realistic insight into processes of manufacturing some well known products. The process of chromium plating is carried on continuously on a small scale, showing the different steps involved as the articles to be plated are conveyed from one bath to another.

Depending on your hobby you can find much of interest in the basic science exhibits. There is a continuous performance of experiments in chemistry, electricity, magnetism, sound, and light that would make many a college lecturer in science envious. The thermit reaction is repeated automatically, measured quantities of iron oxide and aluminum being dropped into a receptacle that travels to contact with electric ignition. The reaction is over in a flash, the iron and alumina falling into a jar of water. Experiments in molecular physics illustrate the scientific basis for dozens of phenomena of daily life. In the sound section you can refresh your memory on how sound travels. You can hear singing tubes and see the vi-

*Diorama in three dimensions of open pit mining*





*Carillon tower of Hall of Science*

brating flames. Electrical models are in operation to explain the fundamental laws discovered by Volta and Ampère, Faraday and Edison. Experiments in light show the reflection and refraction of rays, the use of lenses in telescopes and microscopes, and how eyeglasses correct defects in the lens of the eye. The paths of individual cosmic rays are revealed by means of flashing neon lamps. Finally, if one is mathematically inclined he can see many applications of the "Queen of Sciences" to daily life. Navigation is well illustrated. Probability curves are formed by ball bearings, and the prime factors of numbers are determined by a beam of light and a photo-electric cell. Magic squares and a machine for the composition of simple harmonic motions will fascinate as well as instruct.

In the General Exhibits Group, industry in all its phases is presented in dynamic exhibits, dioramas, murals and products. The Copper & Brass Research Association displays the widespread use of copper and its alloys in pressed, cast, drawn and rolled products for industrial and domestic purposes. A model home embodies the architectural and structural uses of the metals. Copper refining is shown step by step.

Extensive space is devoted to steel in an extraordinary exhibit of the United States Steel Corporation. Blast furnace and reverberatory smelting and the operation of rolling mills are shown in miniature animated models, with clever lighting effects to simulate flowing metal. Dioramas also portray the various mining and metallurgical operations. If you have forgotten how much raw material it takes to produce one ton of finished steel you can refresh your memory at a glance—the materials are all shown in proper proportions. The increasing use of stainless steel is evidenced by products for architecture, food handling, dairying, beverage dispensing, the hospital and the kitchen.

Material handling in all its variety is shown by the Link-Belt Co. Typical chain drives are supported on a central pyramid, the base of which is surrounded by other transmission units, including the P.I.V. variable-speed gear.

The story of oil from producer to consumer is told in relief maps, drilling rigs, pipe lines, refineries and a great variety of uses. A model of a modern refinery enables the visitor to trace crude oil through every step of the process—cracking, fractionation, filtration, storage, distribution, application.

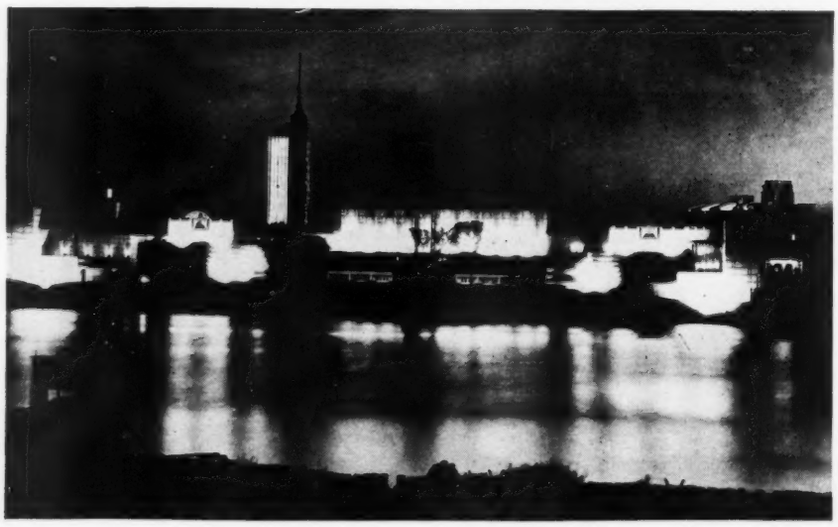
The marvels of electricity make the Electrical Building one of the most fascinating spots on the grounds. Electrical experiments lend themselves to dramatic presentation, and manufacturers have made the most of their opportunity. Westinghouse and General Electric dominate the show with exhibits featuring research and manufacture. General Electric has transported its House of Magic from Schenectady and puts on a continuous scientific vaudeville show in a small auditorium. Gaseous-tube lighting gives a hint of what's coming in illumination. Photo-electric tubes are made to sort black balls from white, giving only a hint of industrial applications. They can be used to control ventilation or indicate smoke issuing from a stack. Electronic musical instruments are represented by a toy-like organ, the size of which is in marked contrast to the tremendous volume of sound it can produce. Other dramatic effects are produced by high-frequency coils, ultra-violet rays, the stroboscope and the oscillograph. Westinghouse shows wireless power transmission, an oscilloscope and several applications of the photo-electric tube, such as operating a fire extinguisher and protecting a bank teller's window from theft. A striking industrial exhibit is a section of a waterwheel generator revolving under plate glass in the floor.

The Bureau of Mines has prepared a good exhibit of its activities in the Federal Building. Murals portray various mining and metallurgical operations. There are working models of a Bureau experimental mining station, of a plant for the recovery of helium. Methods of rescue are demonstrated, and a mine rescue car is to be shown on the tracks near the Transportation Building.

Numerous uses of metals are to be found throughout the exposition. Aluminum Pullman cars in the Transportation Building attract a tremendous crowd. In the model homes, copper, aluminum and Monel metal are used not only for their utility but also in decorative effects that strike a modern note.

Even a short visit will afford a general view of the fair.

*Hall of Science under night illumination*



# Scrap and the Copper Market

## Secondary Metal Steadily Assumes Greater Importance

*Samuel Tzach*

*Former secondary-metals Editor of "E.&M.J. Metal and Mineral Markets"*

NO MERE year-by-year statistical analysis can picture the true and full effect of scrap on the virgin copper market, especially within the past few years, nor can it do full justice to the growing importance of scrap in the metal industries and in the national economy. More definitely indicative of scrap's power are the following, among other, facts: (1) Electrolytic copper refineries have, since the war, shown an increasing and, at times, insatiable and competitive interest in copper-containing scrap. (2) Only last October American Smelting & Refining purchased the business of Federated Metals Corporation, the country's largest scrap-handling and reclaiming organization, operating ten plants. (3) According to a release in 1931 of the Minerals Division, U. S. Bureau of Foreign and Domestic Commerce, that surveyed scrap for 1930, only three large copper companies in the United States can be said to be producing strictly primary electrolytic copper.

### What Is Scrap?

Scrap needs some defining. It connotes, in this article, salvaged material arising from replacing or repairing power, trolley, and telephone lines; from wrecking houses, machines, automobiles, and battleships; and from similar activities. Examples are: copper wire, copper and brass castings, automobile radiators, and brass pipe. It also connotes discarded copper or copper-containing material at the rolling mill, foundry, machine shop, smelter, refinery, chemical plant, and factory, that is not re-used by the company in whose plant it originates. Examples are billet crops, sheet clippings, brass skimmings, turnings, scale, faulty ingots. And the term secondary copper may be defined as the copper content of scrap and residues that have been smelted, refined, or melted into new metal or alloys or castings, or bound into chemicals like copper sulphate.

Scrap may be called old or new—or it may be called junk, as the American Bureau of Metal Statistics has been calling it—but, as a raw material, it needs no apologists. If copper ore running 2 per cent copper is good ore, brass foundry ashes assaying 5 per cent copper is very good source material, and yellow brass scrap running 50 to 70 per cent copper, red brass and bronze assaying 80 to 90 per cent copper, and copper wire and castings yielding 90 to 99 per cent copper are raw materials beggaring description.

Scrap not only is raw material able to compete with ore, but it is also in direct competition with virgin electrolytic copper. Even in this age of electricity and electrolytic copper, the big or large foundry, for one, may either buy scrap, secondary copper, and alloys, or it may turn to virgin metals. Last year, for instance, secondary red brass ingots were, at times, quoted too high in relation to virgin metals, and some large founders purchased virgin copper and other virgin metals instead. The bluestone manufacturer can switch from copper scrap to standard or blister copper when such an operation saves him money. Even fire-refined copper from wire may take the place of electrolytically refined copper in wiring. At least, Western Electric's subsidiary, Nassau Smelting & Refining Company, purchased by the utility in October, 1931, makes from utility scrap a fire-refined "electrolytic quality" copper which it not only uses itself but offers for sale.

In this regard mention may also be made of the fact that when foreign consumers of virgin copper wished to show their disapproval of the regulations and accords of Copper Exporters in recent years, they curtailed their purchases of virgin copper and increased their buying of scrap and secondary copper and alloys. Especially has this been true of countries like Germany and Japan, whose electrolytic refineries can turn scrap into electrolytic copper. And it was the hundreds of thousands of tons of war scrap that strangled the copper markets here and abroad in 1920 and 1921. Not until most of the scrap was absorbed by foreign and United States consumers and our copper mines shut down for a year did the virgin copper market recover. Even in this age of electricity, it is well to remember that copper, although available scrap statis- This fact explains why scrap and secondary copper have affected the domestic and world price of electrolytic copper.

### Statistics and Statistics

At this point a statistical summary may help give a bird's-eye view of the relationship of virgin and secondary copper, although available scrap statistics, regrettably, seem in great need of clearing up. The scrap recovery figures of the U. S. Bureau of Mines, which are used and are practically the only ones available over a period of time, have been criticized as probably too large. United States Bureau of the Census figures for 1929, for instance, give only 34,198 tons of secondary copper produced as copper by secondary smelters, as compared with 130,521 tons reported by the Bureau of Mines. However, another check, the scrap survey for 1930 by Dr. J. W. Furness, head of the Minerals Division, is not too far out of line with the Bureau of Mines reports. The survey for 1930 showed copper and brass scrap purchases by primary and secondary smelters and refiners and by brass mills and foundries as 382,628 tons (including 55,000 tons of new clippings), and the Bureau of Mines reported a total of 524,800 tons copper and brass scrap recovered (467,200 tons copper content), a difference of 142,172 tons. Inasmuch as a large secondary alloy manufacturer is understood not to have made any report to the survey, the discrepancy may be considered relatively small.

### Figures Duplicated

On the other hand, that both the survey and the Bureau of Mines figures contain duplications is not unlikely. For instance, a possibility is that some of the blister copper reported as made from scrap by secondary smelters and then sold to primary refiners or for export may be counted twice. Also, some of the scrap purchased and exported by secondary ingot makers may appear in these reports. Although the available statistics leave much to be desired, the table may be found helpful for a general view of the situation, but scrap's influence on the copper market will be shown as important regardless of the exact statistical relationship.

Illuminative general facts to be noted from the table are: (1) The average total secondary copper for the years 1920-1931—419,352 tons—was 59 per cent of the average United States smelter output, 42 per cent of the average primary refined production, and 66 per cent of the United States virgin consumption. (2) Output of electrolytic copper from scrap by primary refiners during 1920-1932 averaged 10 per cent of the virgin refined output, 13 per cent of the smelter output, and 15 per cent of the consumption of virgin.

(3) The combined output of secondary copper as copper by primary and secondary refiners for 1920-1931 averaged 17 per cent of the refined virgin output, 25 per cent of the smelter production, and 28 per cent of the virgin consumption. (4) In depression years like 1921-1922, when copper output was drastically curtailed by a mine shutdown, and again in 1930, 1931, and 1932, the ratio of secondary copper recovered both as copper and in alloys was well above the average. (5) The trend in the percentages of total scrap recovery used by primary refiners has been distinctly upward, from 13 per cent in 1920 to 30 per cent in 1930.

## Relationship of U. S. Secondary Copper and Virgin Copper

(In Short Tons)

| Year | (A) U. S. Virgin Consumption | (B) Total U.S. Virgin Refined Output | (C) U. S. Smelter Output | (D) Total U. S. Secondary Copper Recovery. (Includes Copper Content of Brass and Other Alloys) | Percentages D÷A | D÷B | D÷C | (E) Secondary Copper Produced by Primary Refiners | Percentages E÷A | E÷B | E÷C | E÷D | (F) Secondary Copper Produced as Copper by Secondary Refiners | Percentages F÷A | F÷B | F÷C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1920 | 526,919 | 772,260 | 604,531 | 312,460 | 60 | 40 | 57 | 40,994 | 8 | 5 | 7 | 13 | 57,006 | 11 | 8 | 9 |
| 1921 | 305,494 | 503,212 | 252,793 | 217,300 | 71 | 43 | 86 | 53,243 | 17 | 11 | 21 | 24 | 45,777 | 15 | 9 | 18 |
| 1922 | 448,317 | 667,849 | 475,143 | 335,900 | 75 | 50 | 70 | 73,005 | 16 | 11 | 15 | 22 | 40,395 | 9 | 6 | 8 |
| 1923 | 650,237 | 995,615 | 717,500 | 410,900 | 63 | 41 | 57 | 65,719 | 10 | 7 | 9 | 16 | 75,581 | 12 | 8 | 11 |
| 1924 | 677,371 | 1,120,717 | 817,125 | 388,300 | 58 | 35 | 48 | 77,409 | 11 | 7 | 9 | 20 | 64,091 | 9 | 6 | 8 |
| 1925 | 700,506 | 1,107,091 | 837,435 | 420,210 | 60 | 38 | 50 | 99,180 | 14 | 9 | 12 | 24 | 84,520 | 12 | 8 | 10 |
| 1926 | 785,068 | 1,155,874 | 869,811 | 479,800 | 61 | 42 | 55 | 112,559 | 14 | 10 | 13 | 23 | 87,541 | 11 | 8 | 11 |
| 1927 | 711,480 | 1,169,868 | 842,020 | 490,200 | 69 | 42 | 58 | 104,934 | 15 | 9 | 12 | 21 | 96,066 | 14 | 8 | 11 |
| 1928 | 804,269 | 1,254,544 | 912,950 | 536,400 | 67 | 44 | 59 | 116,300 | 14 | 9 | 13 | 22 | 113,700 | 14 | 9 | 12 |
| 1929 | 889,293 | 1,376,112 | 1,001,432 | 626,550 | 71 | 46 | 63 | 167,079 | 19 | 12 | 17 | 26 | 130,521 | 15 | 9 | 13 |
| 1930 | 632,508 | 1,097,611 | 697,195 | 467,200 | 74 | 43 | 67 | 140,270 | 22 | 13 | 20 | 30 | 104,530 | 17 | 9 | 15 |
| 1931 | 451,033 | 771,903 | 521,356 | 347,000 | 76 | 45 | 67 | 78,064 | 17 | 10 | 15 | 23 | 110,236 | 24 | 14 | 21 |
| 1932 | 259,601 | 395,993 | 272,005 | (a) | .. | .. | .. | 60,194 | 23 | 16 | 22 | .. | (a) | .. | .. | .. |
| Total | 7,842,096 | 12,388,649 | 8,821,296 | (b) 5,032,220 | .. | .. | .. | 1,188,950 | .. | .. | .. | .. | (b) 1,009,964 | .. | .. | .. |
| Aver. | 603,238 | 952,973 | 678,561 | (b) 419,352 | 66 | 42 | 59 | 91,458 | 15 | 10 | 19 | 21 | (b) 84,164 | 13 | 8 | 12 |

(a) Not available.
(b) For 12 years (1920-31).
Tables A, C, D, E, F, from U. S. Bureau of Mines publications. Table B from American Bureau of Metal Statistics Year Book.

Copper-mining companies can hardly keep from feeling that a total scrap copper recovery of 419,352 tons is a millstone around the neck of the virgin copper market. Some have tried to escape its implications by denying that scrap bought and used by mills and foundries and refined into alloys by secondary smelters can have any effect on the copper market; in other words, that only secondary copper sold as copper—electrolytic and casting copper—ought to be considered. As already pointed out, copper in scrap is copper to the consumer when needs or cost make its use advantageous. And, since 1916, when custom smelter refineries learned to use brass scrap freely, as well as copper scrap, in the production of electrolytic copper, no closed circle has existed for brass-scrap consumption. Scrap brass may go to the foundry, the brass mill, the secondary alloy manufacturer, or the electrolytic refinery, or it may go abroad to similar outlets. Only rolled brass scrap, returned to the mills by their customers at prices changing with the copper market, can be classified as scrap that may not affect the demand for virgin copper. As a matter of fact, for a large part of last year and this year, refineries have been getting much yellow and red brass scrap that would normally go to the secondary alloy ingot manufacturer, because the latter normally will pay for the tin or zinc in the alloys, whereas the refiner will, as a rule, pay only for the copper recoverable from the alloy.

### The Secondary Alloy Industry

In this connection, the position of the secondary alloy ingot maker should be understood. Before the primary refiners discovered scrap, many firms starting as scrap dealers had already established profitable connections, selling scrap and remelted ingot to foundries and rolling mills, and, during the World War, the larger ones had expanded their plants, built reverberatory furnaces, some of 50-ton and greater daily capacity, and established chemical and metallurgical control, so that they were able to make ingot to meet the specifications of various classes of consumers. Probably large and small brass ingot makers total 50, with a capacity of 200,000 to 300,000 tons a year, and supplying the majority of the 300 large and small job and manufacturing foundries with ingot when they are not supplying them with scrap. The Minerals Division survey listed more than twenty separate industries served by the secondary alloy manufacturer.

### A Significant Purchase

These secondary-metal producers form an important branch of the metal industry, and the purchase of the largest secondary alloy maker by American Smelting & Refining may be considered a sign not only that this primary metal producer recognizes that scrap is valuable raw material but also that, if it can't sell foundries virgin metals, it may very profitably be able to sell them secondary ingot. The advantage that secondary alloy manufacturers have over primary metal producers is that they normally sell their ingot at a half cent and more below the value of a similar alloy made of virgin metal. Thus, if the constituent new metals of an 85-5-5-5 brass alloy (85 Cu, 5 Sn, 5 Pb, 5 Zn) would cost the foundry 9c. per pound, the secondary alloy is offered to him at 8.50c. or even 8c. And, as already indicated, in buying his raw material—scrap—the secondary ingot maker can, if compelled to by competition, pay for the zinc in the yellow brass and the tin in the red brass.

The effect of the secondary ingot business on the virgin market may not be stated in exact percentages, but it cannot but be considerable, being, perhaps, as great as the effect of the scrap that returns as pure refined copper.

And, to show what a factor this secondary unalloyed copper has been in the copper market's recent history, only the secondary metal produced by primary refiners need be considered. Eliminating an almost equal amount of secondary copper produced as copper by secondary refiners will focus sharply the effect secondary copper has had on virgin copper prices. Surely, one may say, a mere 91,458 tons of electrolytically refined copper produced from scrap by primary producers (which amount is the average of the past thirteen years, and is but 10 per cent of the total refined virgin copper and 13 per cent of the smelter production) cannot affect the price of ten times as much virgin metal.

In the first place, one should note that secondary copper production by primary refiners has, in some years, run considerably beyond the 10 per cent average. In 1921 and 1922 it was 11 per cent, and in 1932 it was 16 per cent, and the average for the last three years has been 12 per cent. Second, as these facts may suggest, the power of scrap and secondary copper on the virgin price can be best studied in an abnormal market.

Wars, depressions, "corners" in virgin copper, and similar emergencies, when

for one reason or other virgin copper has been in inadequate supply or considered too highly priced, have brought secondary metal to the front of the stage at various times. Scrap's rôle is important because mines can be shut down or virgin output controlled, but not scrap. Depressions cut down the supply of scrap because few metal plants are working and there is a minimum of repairing and scrapping, but the supply is not wholly dammed. Nor has anyone ever attempted to corner or control the supply of scrap. The price of virgin copper may affect the mining of ore and the production of the refined product, but it will affect the scrap flow much less. When copper ore is being mined at a loss, scrap has a great advantage as a raw material. It can never command quite as high a price as virgin copper. As material for the blast furnace, converter, or refining furnace of the electrolytic refiner, its value can be only the selling price of the refined copper minus the costs of smelting and refining and selling the secondary metal.

The profit to the refiner in handling scrap may be larger or smaller, or at vanishing point, depending on the refinery's need for scrap and the competition it faces in scrap. Thus in 1930 refiners charged 1.50c. a pound for refining No. 1 copper wire scrap (running 98-99 per cent copper), but in 1932 and 1933 they have been charging only 0.75c. a pound. In other words, their need for scrap caused them to reduce their profits by $15 a ton in handling this grade of scrap. And, no special emphasis is needed to make clear the fact that when the cost of mining and producing virgin copper is greater than the sales price—double and more than double, for instance, during 1932 and part of this year—not only is the use of scrap profitable, its value being set by the copper price, but that such virgin copper production may be practically stopped and secondary copper be permitted to bear the burden of supplying consumers is also absolutely imperative in the interest of the country's resources.

## Refinery Use of Scrap

Secondary electrolytic copper has been able to affect the domestic and world copper prices because it is custom smelter copper, metal that must be sold by the refiner to establish the price he is to pay the shipper of the scrap. Purchasing of scrap by custom smelters, done on a basis similar to that used in the buying of ore, is only a relatively recent development, and one that has been practically unnoticed, historically. Refineries had probably been users of scrap before 1900, but not until 1903, when Balbach Smelting & Refining Company, at Newark, N. J., found it could use copper-bearing residues, such as foundry ashes and skimmings, was a regular custom-buying basis for scrap established. Not until 1916 did Norfolk Smelting & Refining Company, at Norfolk, Va., come into the picture, and its contribution was the discovery that it could use as much brass scrap as copper matte from ore in its converters. Not until 1920 did American Metal begin using scrap at Chrome, N. J. Nichols Copper followed at Laurel Hill, Staten Island, about five years later, and American Smelting & Refining, which also had begun to use scrap at Tacoma, Wash., Baltimore, Md., and Perth Amboy, N. J., at about the same time, only became an active scrap purchaser in 1931, and not until this year did it begin to use brass scrap at its Perth Amboy plant.

## Settlement Practice

Custom smelters generally take scrap as they take ore, and charge for smelting, refining, and selling the metal, although they have also been buyers of scrap, mainly copper wire, in recent years outright at a flat price, when competition with foreign buyers has been keen. Payment is made to the shipper, generally on the basis of prices ruling in actual sales of copper, as reported to and averaged by *E.&M.J. Metal & Mineral Markets*, for the week of arrival of shipment or for the week after arrival. Refiners' profits are conceived as flowing from operations only, and not from stocking or future sales of custom metal. Custom metal is therefore metal that must be sold and, given a thin or artificial market, it will be offered until a buyer is found. If consumers—and some of the largest of these are subsidiaries of the large primary copper producers—refuse to take up the unsold custom smelter "intake" at the prevailing price, a fictitious market cannot be maintained.

Since 1930 custom smelter copper has been, in fact, the tail that has wagged the whole copper market downward, and, inasmuch as custom ore supplies have practically dried up in the last few years, custom secondary electrolytic has been forced to do the wagging. In active and high copper markets, like those of 1928 and 1929, when refinery output was running around 25,000 tons a week, a custom smelter output of 5,000 tons was an ineffective tail, but when the virgin refined output drops to 8,000 tons and even 4,000 tons a week, and consumption is even lower, as in much of 1932 and this year, a custom smelter output of 1,000 to 2,000 tons a week, nearly all from scrap, has been a devastating tail.

In 1930 scrap undoubtedly helped "break" the copper market. As long as consumers were willing to pile up custom smelter metal, the 18c. market held, but, when they stopped, the pressure from custom smelter copper forced the 4c. reduction. Faced by a continued buyers' strike, custom smelters had cut their outright buying prices on scrap drastically, practically retiring from the market, but they had previously contracted heavily for monthly scrap shipments through 1930 and they had to take all the scrap that was shipped to them. Scrap shippers, influenced by the drastic cut in outright bids for scrap, sent forward the maximum tonnages allowed by their contracts. Much material found its way to refineries that normally went to ingot makers, and even secondary refined alloys are known to have been dumped on the custom smelter. Under the circumstances, pressure from custom smelter metal was inevitable.

## Scrap a Price Control Factor

And since 1930 custom smelter copper—to an increasing extent secondary copper,—seemingly has, in the main, set the world price for the virgin metal, because such refinery output as has been possible has, until the last few months, been consistently greater than the demand. With three-quarters of a million tons of copper piled up here, and domestic and foreign consumers aware of it and in need of very little metal, that custom smelter secondary metal steadily forced the virgin price down until it touched its all-time low of 5c. is not surprising. Unjustly, perhaps, have custom refiners been blamed for serving as the unwilling instrument of the supply-and-demand relationship. Warily they had made few scrap contracts in 1931 and 1932, but their need for scrap had increased. The country's mine output had been cut to 20 per cent and less, foreign ore supplies had diminished, and then (since June 14, 1932) had been shut off by a 4c. duty on copper, and only available taxless in bond, and foreign countries were competing for scrap and actually taking it away in large quantities. The 50 per cent reduction in custom smelters' refining charge on No. 1 copper scrap, already mentioned, was eloquent of their great need for scrap during these past years.

# CALIFORNIA GOLD

## Intensity of Search for the Metal Steadily Increasing

*J. B. Huttl*

*Assistant Editor*

MINING activity has increased in various parts of California during the past year, and the developments in the Grass Valley, Nevada City, and Mother Lode districts are among the most interesting phases of the rewakening. A visitor to these regions cannot but be impressed by the amount of change that is going on constantly. The countryside is spotted with prospect shafts and trenches, and numerous unemployed from almost every part of the land populate the valleys, in an effort to eke out a meager existence by panning and washing the stream beds.

A factor largely responsible for increased activities and rehabilitation of dormant properties is the successful application of flotation for the beneficiation of gold ores. This has made possible the working of low-grade ores hitherto found unprofitable. Another noteworthy feature observed is a change of crushing technique at the newer mills. Jaw crushers for primary crushing, Symons cone crushers and rolls for secondary crushing, ball mills for grinding, and flotation of ores have replaced stamps, amalgamation, and concentration, still used at older plants.

The preceding observations, and the following semi-technical account of California gold-mining activities, are the result of a visit made to mines and mills in Grass Valley, Nevada City, Georgetown, and the Mother Lode late in May.

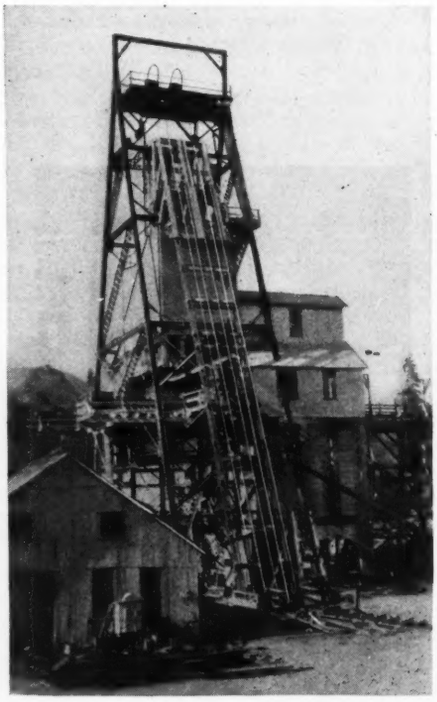
At Nevada City two major enterprises are producing, the Murchie mine, Newmont subsidiary, and the properties of Hoge Development Company. A number of smaller mines, including the Canada Hill mine of Western Mines Corporation and the Lava Cap, recently acquired by the Hoge company, have been rehabilitated, and more or less active exploration is in progress. In addition, several old properties are in the throes of preliminary refinancing.

The Murchie mine and mill have been recently equipped with new machinery and are in excellent condition. The company has retimbered and sunk the original three-compartment shaft an additional 300 ft. to the 1,600-ft. level, preparatory to the comprehensive plan of development now in progress. Production varies up to 300 tons a day. The ore, mined by cut-and-fill methods from quartz veins embedded in granodiorite, is hard and tough.

The mill flowsheet is simple. From the storage pocket on the headframe the ore is conveyed by cable-operated end-dump cars to the mill, and dumped onto a steel grizzly with 2-in. openings. Undersize falls directly into the mill bin, and the oversize is crushed to 1½-in. by a 9x15-in. Blake crusher. The stored material is fed automatically to twenty 1,600-lb. stamps driven by water power and operating at 120 drops per minute. Mortar discharges are covered with ½-in. slot screens.

Fine grinding is done in a 5x12-ft. ball mill operating in closed circuit with a Dorr Class F classifier. The sands are returned to the ball mill by a short screw conveyor attached to the upper end of the classifier. Sodium sulphate and pine oil are fed at the head of the ball mill by Kraut reagent feeders. Consumption is 0.02 lb. and 0.15 lb. per ton, respectively. The classifier overflow, a 100-mesh product, passes to two six-cell Kraut roughers set in tandem. The tailing flows by gravity to the waste dump, and the concentrate is retreated in a two-cell Kraut cleaner machine. Cleaner tailing returns by a duplex elevator to the first rougher.

Reagents used are Z5 xanthate and pine oil. Xanthate consumption is 0.001 lb. per ton. Pine oil is fed to the fourth cell of the first rougher and to the third cell of the second rougher machine, to produce the necessary counter current. Constant feeding of pine oil at the head of the ball mill supplies the frother for the first cell. Consumption of pine oil is 0.15 lb. per ton of ore milled.



New Idaho-Maryland headframe

Automatic samplers installed at strategic points sample periodically the concentrate produced by the cleaner machine, and flotation feed and tailings. From the cleaner machine the concentrate passes successively to a 15x15-ft. Dorr thickener and a 3x4-ft. Oliver filter, prior to shipment to the Empire mill for cyanide treatment. Ratio of concentration is 55 to 1. About 200 men are employed at the mine.

The Hoge property is about 7 miles north of Nevada City. The incline shaft is now at a depth of 800 ft. and sufficient ore is produced to keep the 80-ton mill in operation. An innovation at the mill is the use of rolls for secondary crushing. No stamps are employed. The flotation practice is similar to that at the Murchie mill.

In the Grass Valley area large-scale operations are in progress at three properties: the Empire, the North Star, and Idaho-Maryland. Underground workings at the Empire and North Star mines have reached an incline depth of 7,000 ft. and 9,200 ft., respectively. Milling operations continue at the rate of 800 tons a day. Kraut flotation machines have been installed recently for re-treating the vanner tailing. Few or no changes have been made in the milling plants save for maintenance.

The Idaho-Maryland is operating twenty stamps at the old mill and twenty stamps at the Brunswick mill, milling about 200 tons of ore a day. Operations at the Brunswick mine have been discontinued, and the shaft has been permitted to fill with water. Discovery of a potential orebody on the 1,950-ft. level in the old mine has added considerable tonnage to available ore reserves. Noteworthy results have been obtained at the Brunswick flotation plant. Improvements at the mine, involving considerable expenditure, include a new steel headframe and the addition of larger air-compressor equipment. Present plans also include the erection of a central milling plant and sinking of a new shaft.

The Golden Center mine, in the heart of Grass Valley townsite, is operating ten stamps of its twenty-stamp mill. Amalgamation and concentration have been discontinued. The 40-mesh battery product is treated exclusively by a four-

cell Kraut rougher and a two-cell Kraut cleaner machine. At the mine the incline shaft has been deepened to 1,600 ft., and a new power house, containing a 500-hp. McIntosh-Seymour diesel engine and waste-heat boiler equipment, is being erected adjacent to the mill. The property is controlled by Cooley Butler.

At the Empress mine, situated 4 miles northwest of Grass Valley, activities are centered in sinking the shaft to 1,000 ft. This property, on which work was abandoned during the World War at a depth of 150 ft., was reopened some time ago by E. C. Jacobs.

The reopening of old properties southwest of Grass Valley is of considerable interest, as a number of quartz veins have been opened in times past and ore has been produced. In the Rough and Ready areas prospect work is under way at the Black Bear, the Mistletoe and the Osceola and Olympus group. Examinations for reopening have been made at the Gold Mound and Sunflower properties. At Deadman Flat, the Alcalde, the West Point, and the Normandie-Dulmaine mines are being reopened.

Northwest of Grass Valley the Grass Valley Prospecting & Development Company is endeavoring to finance prospect work on the Personeni Ranch veins, and a new company, known as Grass Valley Premier Gold Mines, has reached a depth of 100 ft. in its shaft, sunk on a strongly mineralized vein in the Hocking Ranch, near Kentucky Flat.

Other new enterprises commencing activities within the Grass Valley district include the reopening of the old Bullion mine, on the Auburn-Grass Valley highway, and exploration of the Gold Blossom claim and others.

The outcome of the activities here recorded will depend upon the financial strength of the companies concerned and the persistence shown in exploration. Many veins exist, whether they contain commercial ore can be determined only by well-directed development work backed by good management and adequate capital.

Leaving Grass Valley, the next objective is Georgetown. Three major enterprises are operating in this district: the Beebe mine, controlled by Atolia Syndicate, a Bradley subsidiary; the Sliger property of the Middle Fork Gold Mining Company; and the project of the Canyon Creek Dredging Company.

At the Beebe mine, development of the Beebe orebody continues. The company has also acquired the Alpine mine, in Garden Valley, and the Eureka-Woodside mine, adjacent to the Beebe, where a permanent connection between both mines has been made. Production of the Eureka-Woodside is hoisted to the surface through the Beebe shaft. The Alpine shaft has been unwatered to 400 ft., and about fifteen men are employed in general development work. Ore is trucked to the Beebe mill. Operations have been suspended temporarily at the mill, pending completion of changes made on the Hadsel mill and reorganization of milling practice. Production is from 300 tons to 350 tons a day, with 200 tons being drawn from the Beebe mine and the remainder coming from the Eureka-Woodside and Alpine.

The Sliger mine is milling about 100 tons of ore a day. Plans are maturing for a change in crushing practice, involving the installation of a jaw crusher for primary crushing and a Symons cone crusher for secondary crushing, in place of the fifteen stamps now used. Grinding is performed by a 64-in. ball mill that operates in closed circuit with a 6x22-ft. Dorr classifier. The classifier overflow is 5 per cent on 100 mesh. The flotation department contains a six-cell Kraut rougher and a two-cell Kraut cleaner machine. Sodium sulphate is added to the battery product at the head of the ball mill, and pine oil is fed to the third rougher cell. Total reagent consumption in pounds per ton of ore milled is as follows: pine oil, 0.40 lb.; xanthate, 0.20 lb.; copper sulphate, 0.40 lb.; sodium sulphate, 0.30 lb.; and soda ash, 0.25 lb.

Tailing from the rougher machine goes to waste after passing over a Deister concentrating table, and the overflow goes to the cleaner cells. The cleaner overflow is treated successively in a 4x4-ft. Devereaux agitator, a 10x12-ft. Dorr thickener, and a 3x4-ft. Oliver filter, prior to shipment in the form of dry concentrate to the Selby smelter.

Available dredging ground in Canyon Creek, near Georgetown, is about 2 miles in length, the width varying according to the contour of the canyon floor. A total production of 880 yd. a day is being made by the Peake Engineering Company's dredge, which is treating ground that contains as high as 27c. in gold per yard. The dredge has a capacity of 1,500 yd. of gravel a day, consuming 150 hp. at full load. Maximum digging depth is 10 ft. The bucket line operates at a speed of twenty-one buckets a minute. Hungarian riffles are used on the sluices and tables.

In the Jackson and Plymouth areas of the Mother Lode mining district, four major properties are in operation: the Kennedy, the Argonaut, Central Eureka, and the Montezuma.

The Kennedy mine is operating 40 stamps and milling about 180 tons per day. At the mine, sinking is in progress for another 150 ft. in depth, which will advance underground workings to a depth of 5,250 ft. Apart from the installation of a flotation plant about a year ago, no major changes have been made at the mill. Preparations for retreating the old tailing dumps by flotation are being completed at the plant.

Central Eureka at Sutter Creek and the Argonaut at Jackson are milling at the rate of 150 tons and 250 tons, respectively. Sixty stamps are in operation at both mills. The ore is treated by amalgamation and concentration. Tailing is re-treated in a custom plant.

At the Montezuma mine, near Plymouth, the newest producer on the Mother Lode, shaft sinking has been completed, and development work is in progress on various levels. The property was acquired early in 1933 by the Montezuma-Apex Mining Company, a subsidiary of the Utah-Apex Company, of Utah, and was equipped with a modern surface plant and a 100-ton mill. Operations at the mill commenced late in March. Production is 105 tons a day.

**Dredge in Canyon Creek**

Of the many smaller enterprises in course of development in the Plymouth and Jackson districts, the Ophir mine, near Plymouth, operated by Hotchkiss & Williams, of San Francisco, is actively producing. The mine is opened by a 60-ft. shaft, which is being deepened, and an adit. A three-stamp mill is available for milling. Ore is mined by hand methods from a blanket deposit that dips at an angle of 15 deg. The stamps and a mechanical vanner are driven by a 10-hp. Stower gasoline engine. Concentrate and high-grade ore shipped to the Selby smelter.

The outstanding development in Calaveras County is the reopening of the Carson Hill mine, at Melones, by the Anglo-American Mining Corporation. Crews are at work underground and on the surface, reconditioning the old workings and the mill. Production is to start early in July.

# *Personal Notes·Comment·Criticism*

**C. Erb Wuensch** is in New York.

**H. T. Hamilton** has returned to New York after a trip to Europe, which included a visit to the Rio Tinto mine, in Spain.

**H. W. Gould,** mining and metallurgical engineer of Gould & Company, San Francisco, is in Washington, D. C., on business.

**Horace G. Young** has just returned from examining properties in the Matachewan and Tyrrell township areas of Ontario.

**H. A. Angus** has been appointed a director of Beattie Gold Mines, Ltd. Mr. Beattie was the original operator of these mines.

**T. B. Gyles,** of the National Smelting Corporation, Bristol, England, has been granted the M.Sc. degree of Melbourne University.

**Henry Urquhart,** consulting engineer to Anglo-Australian Gold Development Company, is visiting Australia, accompanied by **L. C. Cutbill,** a director.

**P. H. Reagan,** mining engineer, has left Oregon for Monterey, Calif. He expects to be in California all summer on professional business.

**A. E. Wheeler,** consulting metallurgical engineer, of New York City, returned early in June from a two months' business trip to Europe.

**R. S. H. Richard,** mine superintendent of the S. Domingos mine, at Mertola, Portugal, expects to be in England on leave during July and August.

**J. C. Houston** has succeeded I. M. Marshall as mine manager for Central Manitoba Mines. Mr. Marshall had resigned to take charge of Reno Gold Mines.

**Oscar A. Glaeser** has resigned his position as a safety engineer with United Verde Copper, to take up safety work in California, with headquarters in San Francisco.

**N. E. Giblin,** formerly superintendent of the west coast mines of the Electrolytic Zinc Company, has been appointed general manager of Mt. Coolon Gold Mines, Queenslanc.

**E. L. James** has been appointed manager of Titanium Products Ltd., which is treating by magnetic separation the black sands at Naracoopna, King Island, Tasmania.

**Malcolm Muir**, president McGraw-Hill Publishing Company, Inc., has been appointed a Deputy Administrator of the National Industrial Recovery Administration. His appointment represents a cross-section of industry, due to his familiarity with the capital goods and machinery groups. Mr. Muir is a past president of the Associated Business Papers, a director of the National Publishers' Association, the American Arbitration Society, and the Merchants Association of New York. As a member of the National Committee for Industrial Rehabilitation, he was an active worker for industrial recovery a year before the new law was enacted.

**LeRoy Salsich,** president of the Oliver Iron Mining Company, a subsidiary of the United States Steel Corporation, with properties in Minnesota, Michigan, and Wisconsin, has initiated a policy of employee representation in effectuating the provisions of the National Industrial Recovery Act.

**F. R. Weekes** has returned to Vancouver from an examination in California. He is proceeding to the Kootenay district, British Columbia, where he will be occupied on professional work.

**F. G. Brinsden,** general manager of South Kalgurli Ltd., Kalgoorlie, Western Australia, has been elected president of the Australasian Institute of Mining and Metallurgy.

**T. H. O'Brien,** general manager of Inspiration Consolidated Copper, attended a conference of state chairmen of public welfare in Washington, during the past month.

**O. E. Keough,** concentrating engineer of International Smelting Company, Tooele, Utah, is now at the Sliger mine of the Middle Fork Mining Company on professional work.

**Carl J. Trauerman,** of Butte, was the principal speaker at the annual meeting of the Beaverhead Mining Association, held at Dillon, Mont., on June 17. His topic was "Gold and Silver."

**Dr. C. A. Heiland,** professor of geophysics, Colorado School of Mines, addressed the Geological Society of Chicago on May 18, at its last spring meeting, on the subject of the exhibit.

**J. O. Betterton,** chief of research, and **T. E. Jones,** office manager, of the American Smelting & Refining Company, Perth Amboy, N. J., were in Salt Lake City recently on an inspection trip.

**Sir John Cadman** recently was awarded the gold medal of the Institution of Mining and Metallurgy for his attainments in the advancement of technical education and the development of the mineral industries.

**Robert A. Bryce,** of Toronto, who for three years has been directing deep exploration at the Macassa mine, at the western end of the productive area at Kirkland Lake, has announced that a 200-ton mill will be erected.

**W. F. Kurfess,** manager of the Mill Department of Joseph T. Ryerson & Son, Inc., has been appointed assistant vice-president of the company. **M. J. Hartigan** succeeds Mr. Kurfess as manager of the mill department.

**M. W. Hayward,** consulting engineer of Compania Minera de Peñoles, S. A., has been in Cuba on professional work for several months, and is coming to New York for a short visit, after which he will return to his headquarters in El Paso, Tex.

**Robert E. Strathorn,** capitalist and railroad builder, has been made president of the Pacific States Mines and will furnish equipment for developing the Opp mines, near Medford, Ore.

**C. A. Banks,** managing director of Bulolo Dredging, has been awarded the Consolidated Goldfields gold medal, given by the Institution of Mining and Metallurgy, for a paper on the air transportation of dredges in New Guinea.

**Lawrence B. Wright,** formerly with Homestake Mining Company, is engaged in private consulting practice with headquarters at Lead, S. D. He has written recently from Ontario, where he has been examining mining properties for private interests after having completed a similar program in Montana.

**Robert J. Grant,** former Director of the United States Mint, has arrived in China and assumed direction of the new China Central Mint, in Shanghai, according to word received at Washington. Distribution of a new silver dollar, issued to replace other media of exchange, has been begun as of July 1.

**Dr. W. O. Hotchkiss,** president of the Michigan College of Mining and Technology, at Houghton, Mich., is making an advance tour over the Lake Superior route over which a group of those attending the International Geological Congress, to be held this month in Washington, D. C., will be conducted.

**Dr. C. K. Leith,** professor of geology, University of Wisconsin, has been appointed chairman of the Subcommittee on Reporting and Publication Policy of the United States Department of Commerce Business Advisory and Planning Council. **E. T. Stannard,** of New York City, president of the Kennecott Copper Company, is also a member of the committee.

**Ernest R. Lilley,** associate professor of geology at New York University, with Mrs. Lilley, expects to start this month on a tour that will embrace Atlanta, Tulsa, and points in California, on the trip from New York, returning to the metropolis by way of Salt Lake City, the Yellowstone, Butte, and the Black Hills of South Dakota.

**H. Conrad Meyer,** author of "Processing Witherite" in this issue, is vice-president of the Foote Mineral Company, Philadelphia, Pa., with which company he has been associated more than twenty-six years. Mr. Meyer will be recalled as the regular contributor of the articles on uncommon ores and minerals that appeared in recent years in the annual review numbers of *Engineering and Mining Journal.*

**J. J. Jakosky,** general manager of the International Geophysical Company, at Los Angeles, was awarded the honorary degree of doctor of science by the University of Arizona at the school's recent commencement exercises. During the past year Mr. Jakosky delivered a course of twenty lectures on geophysics at the university. At the same commencement, the degree of engineer of mines was conferred on Paul H. Reagan, who received the bachelor's degree in mining from Arizona University in 1921 and who was until recently chief mining engineer and assistant to the first executive vice-president of the Anglo-Chilean Nitrate Corporation in Chile.

**Errol Mac Boyle,** vice-president and general manager of Idaho-Maryland Consolidated Mines, has returned to Grass Valley, Calif., after a trip around the world.

**Strathmore Ridley Barnott Cooke** has recently received the degree of doctor of philosophy at the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo. He presented a thesis on the "Microscopic Structure and Concentratability of the More Important Iron Ores of the United States." Dr. Cooke is a native of New Zealand. In 1927 he was graduated in chemistry from Otago University and the following year he was graduated in metallurgy from the University of New Zealand. He came to the United States in 1929 and for three years held a fellowship at the Missouri School of Mines in cooperation with the United States Bureau of Mines, Rolla, Mo. For one year he held a teaching fellowship at Carnegie Institute of Technology, Pittsburgh, Pa.

# *The Aura Unit—A New International Standard of Value*

*The Editor:*

I have read Mr. Huntington Adams' article in the April number of *Engineering and Mining Journal,* entitled "Gold Currency Unit for International Exchange." According to Mr. Adams the insecurity in *the gold value of all currencies* is a disturbing feature in international credit, and though Mr. Adams himself says that "in so far as the quantum theory applies to gold—and undoubtedly it does to a considerable extent—the withdrawal of gold from non-gold-standard countries has tended to lower world prices in gold—*to raise the value of gold,* because of its scarcity, in terms of commodities"—he does not in the following consider the most essential fact that *the insecurity in the value of gold itself* is one of the most disturbing features now hampering international credit.

It is necessary to underline that *gold does not represent any stable standard of value,* as the price of this metal fluctuates, and it cannot be expected that when, as at present, the price of gold is rising, and accordingly the prices of all commodities measured in gold are lowered, there should be any confidence in world trade. Therefore, Mr. Adams' conclusion that "the first advantage of the gold gram would be international security in gold value" must be considered an illusive one. Nor can the second advantage mentioned by Mr. Adams —namely, "the establishment of a gold money unit of world-wide acceptance, independent of any nation"—be obtained by means of the gold gram as described by Mr. Adams, as it cannot be expected that all commitments should be made on the basis of unlimited redemption in gold, and without such an obligation there would be no confidence in the gold money unit, which would mean no alteration in the present state of things.

On the other hand, there is no doubt that the weight of one gram of pure gold is the most convenient *basis* for the international standard of value. The point of importance is, however, the value of gold itself, and in this respect I beg to refer to an article in the "Nya Dagligt Allehanda," Stockholm, of March 12, this year, in which I have briefly described the aura—the new international standard of value. The aura unit is an *abstract* one and represents the normal price—that is, the natural value plus the net cost of production—of one gram of pure gold.

Fully to understand the sense of the aura unit, the following facts ought perhaps to be considered:

Under the gold standard the prices of commodities measured in gold money units register all fluctuations in the relation between the value of gold and the value of the commodities. It is evident—to look on the matter with regard to the recent development—that if the value of gold itself rises on account of this metal being subjected to an abnormally great demand there will—from an international point of view—sooner or later set in a depression of the prices of commodities. The depressed prices indicate not only that part of depression which is due to the greater supply of the commodity in relation to gold, but also that part which is due to *the increasing demand for gold.* Thus, if the demand for gold had not increased, no abnormal fluctuations in price would have occurred, and there would have been no reason for lack of confidence in the standard of value.

Under the circumstances gold must be considered a commodity which is subjected to the same economic laws in respect of supply and demand as any other commodity. *Therefore, the concrete factor gold in any unit cannot be a stable standard of value, and its instability in value is in fact so great that it is impossible from a practical point of view to use the metal itself as a satisfactory standard for international trade.*

Nevertheless, no other material is—as mentioned in the foregoing—more suitable than gold for the purpose of being a *basis* for the international standard of value. The possibilities of using gold for this purpose are, however, dependent on the question whether the instability in price created by fluctuations in supply of and demand for gold could be eliminated or not. To investigate this matter it is necessary to analyze the price itself.

The price of gold—as well as that of any other similar commodity—is created mainly by the following three factors: (1) natural value; (2) cost of production; (3) fluctuations in supply and demand. The natural value of gold is high and very stable on account of the scarcity of the metal.

The cost of producing gold varies, of course, in different parts of the world, and it is evident that exploitation of a low-grade gold ore is more expensive than ex-

ploitation of a high-grade one. The cost of production is, however, the determining factor in the volume of gold produced, and therefore if the cost of producing gold were fixed at a certain point, all gold which could be produced at that and a lower cost really also would be produced. There would, however, be no interest in treating gold-bearing ores for which the cost was too high to give any profit.

On the "Cost of Producing Gold," S. D. Strauss has written a very interesting article of great value in the July number, 1932, of *Engineering and Mining Journal*. The figures stated in that article indicate that the average cost of production for 85 mines located in various parts of the world and representing about 75 per cent of the total gold output would be $13.74 in United States gold currency per ounce of pure gold. This figure includes, of course, the natural value of gold. According to Mr. Strauss, the cost varies from $10.20 an ounce in British Africa outside the Union of South Africa, where the cost is $14.43, to $15 in, for instance, British India and Australia. This variation in cost must, of course, be considered important, but nevertheless the average cost of production for most of the gold mines all over the world, no doubt, could be expected to be a rather constant factor in comparison with any other factor that could be considered when choosing a basis for the international standard of value. It must also be taken into consideration that it would mean a great psychological advantage to maintain the connection between gold and the international standard of value. Further, if an international agreement is made that the cost of producing gold should be considered fixed at a certain point in so far as the international standard of value is concerned, this would mean an improvement in the stability of the average cost factor, and possible fluctuations still remaining could scarcely have any great influence on world trade. If compared with the price of gold, the average cost factor, no doubt, could be considered to be the most stable one.

The price created by fluctuations in supply of and demand for gold follows—as mentioned in the foregoing—the same economic laws as prices in general, though under the gold standard—as it has been applied—the effect is expressed reversedly; that is, by fluctuations in the prices of commodities. The present state of world trade proves that the extensive demand for gold has raised the price of that metal to such a height that all confidence in the same as serving the purpose of being a reliable international standard of value has been withdrawn. It is, of course, quite out of the question that the instabiilty in the price of gold would cease. Consequently, the only way out of the difficulties is the establishment of a new international standard of value, in which the value of gold as well as of all other commodities could be measured.

As a result of the argumentation herein briefly described, the aura was invented. One aura is the normal price—that is, the natural value plus the net cost of production—of one gram of pure gold. To meet requirements for practical denomination of values less than one aura, this unit has been divided into the following subordinate units:

1 aura = 10 decars
1 decar = 10 centars
1 centar = 10 millars

The standard of value thus obtained—the aura—is *an abstract factor*, which accordingly cannot be influenced directly by fluctuations in supply and demand.

As regards the practical use of the aura, it is necessary to distinguish between internal and international trade.

There is—at least at present—no reason to abandon the internal standards of value represented by the various currencies. Therefore, the internal trade should as hitherto be carried out on the basis of the currency of each country, but it is, of course, necessary that confidence in the currency is maintained. This is a matter of the central bank of each country.

The efforts could thus be concentrated to the stabilization of the various currencies. This is an international problem which could be solved either in establishing a certain relation between all currencies direct, or indirect in using a stable point against which the stabilization of any currency could be made independent of all other currencies. Of these two alternatives, the latter one is, of course, the most desirable. We have already seen that the concrete factor gold could not be used satisfactorily as a standard of value, but, no doubt, the aura could be expected to be a suitable stabilizing factor.

The central bank of each country could accordingly stabilize the paper currency of the country at a certain relation to the aura, the value of which should for the stabilization be based upon, say, $13.78 United States gold currency per ounce of pure gold, which exactly corresponds to two-thirds of the price paid for gold under the gold standard—$20.67 United States currency. The United States dollar could be stabilized at, for instance, 2,000 auras, the pound sterling at 9,750 auras and the Swedish krona at 0,550 auras. Certainly, central banks would have no technical difficulties in controling their currencies after such a stabilization, and then commitments could be made in auras, which would mean a satisfactory security in value independent of possible fluctuations in the value of the paper currencies, and in the price of gold.

PERCY BURSIE.

*Stockholm, Sweden,*
*May 20, 1933.*

## *A Free Market For Gold*

*The Editor:*

The current gold situation in the United States evokes certain reflections on the heralded "New Deal." American producers of the metal are forbidden by law to export bullion and are thereby forced to accept a nominal $20.67 per ounce for their product. On the other hand, gold mines in other countries, notably Canada and South Africa, are now obtaining $27 to $28 an ounce, or 35 per cent plus more than American producers. If gold has been relegated, *de facto*, to the category of commodities, why should it be specially penalized? By allowing an open market for gold in the United States—as has been suggested—so that the metal might reach a price level comparable to that in London, our government would at once achieve the following results:

1. Place United States gold producers on a parity with those in other countries.
2. Stimulate the development of marginal deposits which at $20.67 an ounce gold cannot be operated economically.
3. Provide employment and generate new business for allied industries.
4. Augment the gold supply held to be vital to our social and economic system.
5. Provide new sources of taxation.
6. Divert flow of American mining investment funds to within our own borders.

Should inflation continue, as Mr. Roosevelt apparently desires, the gold industry here will be progressively hampered with inceasing costs while the price of gold remains constant. This appears to be questionable brain work on the part of the highly publicized "Brain Trust."

ARNOLD HOFFMAN

*New York City*

## OBITUARY

**R. E. M. ("Bob") Strickland,** well known in Northwest mining circles, died recently in Spokane; aged 66 years.

**Patrick J. Jennings,** known for years in the gold fields of the Oregon and British Columbia, died recently at Eugene, Ore.

**F. A. Woodward,** at Globe, Ariz., on June 16, aged 81 years. Mr. Woodward was president of Iron Cap Copper and formerly a state senator.

**E. W. Armstrong,** for 30 years active in the mining districts of Mexico, Central America, New Mexico, and Arizona, at San Francisco; aged 50 years.

**J. Ross Whiteley,** at Globe, Ariz., following an operation for stomach trouble. Mr. Whiteley served as secretary to the superintendent of the International smelter at Inspiration for 18 years.

**Frank J. Higgison,** one of the few remaining veteran Comstock mine superintendents; at Virginia City, aged 75. Mr. Higgison was for many years superintendent at the Hale and Norcross mine.

**C. H. Luja,** in British East Africa; aged 63. Mr. Luja was a captain in the Imperial Light Horse in the Anglo-Boer War and later served with Union Minière and as consulting engineer for C. T. Ganahl, an American capitalist.

**Frederick W. Bradley,** president of Alaska Juneau, a director in many mining companies, and known throughout the mining world for his accomplishments and service, died in San Francisco on July 6, at the age of 70. The news of Mr. Bradley's death was received at the hour of going to press. An appreciation of his career and achievements will appear in our August issue.

**W. B. Townsend,** editor of the Dahlonega, Ga., *Nugget*, established when that village was a gold-mine town, died on June 14 in the printshop of his paper. Townsend wrote no copy with pen, pencil, or typewriter. He set up his news and comment direct in type, and for fifty years the *Nugget* was an institution. Putting in type the words "The editor is sick," Townsend closed his news column and his career.

# BOOK REVIEWS

## A Geophysical Map

LES TRAVAUX DE LABORATOIRE GEOPHYSIQUE. (The Work of a Geophysical Laboratory). *By Dimitry Chahnazaroff; published by the author at the University of King Alexander I at Ljubljani, Jugoslavia; 123 pp., 13 fig.*

Professor Chahnazaroff believes that the increasing importance of geophysical methods of exploration warrants the introduction of a new kind of map, the geophysical map. On this the physical properties of rocks and minerals would have their appropriate symbols, which would be superposed on the already familiar geological ones. Undoubtedly, such maps would aid the geophysicist about to consider the undertaking of a survey in a new region. To demonstrate his point, the author undertook a preliminary laboratory study of suites of specimens from Travnik, a region in Bosnia and Herzegovina. These samples, representative of the igneous, metamorphic and sedimentary rocks of the region, as well as of the economically interesting minerals, were subjected to an investigation of their radioactivity and of their density. The rocks of the region, as a whole, were found to be too homogeneous with respect to these two properties to encourage the use of either radioactivity or gravity measurements in a general way. Certain economic minerals such as magnetite and barite, however, might be prospected for by means of gravity determinations. Of greater interest was the discovery that bauxite, not only from here, but from other regions as well, exhibited distinct radioactivity, leading the author to conclude that this property might frequently be used to prospect for deposits of that mineral.

The second portion of the book is devoted to the author's studies of the behavior of salt water in oil fields. He believes that a sufficiently delicate measurement of the densities of such waters, and of their temperatures *in situ*, will make possible the construction of maps from which can be read the direction of circulation of the subterranean waters. Such information would certainly seem to be of considerable value in the exploitation of an oil field, particularly when the operators are faced with invasions of salt water in their wells.

A more careful proofreading of this book could have eliminated numerous typographical errors. The most serious is the transposition of parts of pages 78 and 82. Others less striking crop up here and there, as, for example, the disagreement between the cover and the title page as to the author's name, and in Fig. 13 the repetition of the same symbol at the head of the last two columns to designate two different values, the density of the waters at 0° and the densities *in situ*.

SHERWIN F. KELLY.

## Rôle of Gold

DIE WARE GOLD. *Goldproduktion und Goldwarenindustrie. Ferdinand Deman. Stuttgart, Germany: Verlag von W. Kohlhammer. Price 7.50 Rm.; pp. 165.*

Although volumes have been written about the part played by gold in the world's trade and its function as a basis for the world's monetary systems, little has been said about its use in industry and arts, a channel into which at least a quarter of the total production is diverted. This dual rôle of gold, its fixed value, and the ease with which it may at any time be converted into ready currency, are some of the factors to be considered in connection with its use as an industrial raw material. International trade conditions, gold movements, and the concentration of the metal in the financial centers of the world are other conditions that must be taken into account in the study of the question. These and many other problems adding to the complexity of the situation have been discussed in an able and interesting manner, and the author has drawn a comprehensive picture of the economic structure of the gold-producing industry. Historical data and a discussion of the world's gold production, with the natural and economic conditions affecting it, have also been included.

## Manchukuo's Minerals

ORES AND INDUSTRY IN THE FAR EAST. *Revised Edition. By H. Foster Bain. Council on Foreign Relations, Inc., New York. $3.*

With events in Manchukuo and Jehol fresh in the public mind, this new and enlarged edition of the book written in 1927 is timely. Dr. Bain has capitalized the interest in Far Eastern affairs by adding a chapter on the resources of the provinces named. Manchuria's mineral wealth is mainly in coal and iron, Jehol's in coal. Coking coal occurs in both. The former province boasts also certain limited and not unimportant reserves of non-ferrous metals and non-metallics. Silver and minor occurrences of gold, lead, and tungsten are found in Jehol. Manchuria's coal vastly outweighs its iron resources, which for the most part require beneficiation and do not constitute an adequate basis for a steel industry of importance. Nevertheless, the coal of both provinces and the iron are a prize for which Japan and China may well be expected to strive, in view of their lack of mineral supplies. The situation depicted and the inferences possible illustrate excellently the book's introductory theme, that minerals are the basis of modern civilization. To emphasize this the better, the opening chapter has been rewritten. Elsewhere the text has been brought up to date, especially the statistical information.

Once again—the Far East is not a treasure house of minerals, as the popular mind has long pictured it. Rather, the countries composing it must of necessity be importers, not exporters, according to Dr. Bain, if per capita consumption of metals and minerals is ever to approach that in the United States and parts of Europe.

A. H. HUBBELL.

## Mapping the Earth

GEOLOGISCHE KARTE DER ERDE. *By Franz Beyschlag, with the assistance of the Prussian Geological Survey. Section I. Verlag von Gebrüder Borntraeger, in Berlin.*

This issue contains the first four sheets of Beyschlag's geological map of the earth, covering that portion of it north of the thirtieth parallel, north latitude. The scale is one to fifteen million. There is included a brief table of time divisions and formational units, printed in German, English, French and Spanish.

The press-work is excellent, and even the minute color dots representing formations of small extent are correctly registered. The colors used are strongly contrasted so that the different formations stand out sharply. The scale of the map is so small, however, that the geology is, necessarily, highly generalized. The map should serve a useful purpose and is a welcome addition to our map files.

R. J. COLONY.

## Publications Received

*Chromite Deposits of the Eastern Townships of the Province of Quebec.* By B. T. Denis. Part D, Annual Report, 1931, Quebec Bureau of Mines, Quebec. Pp. 106.

*Limestone Deposits of Tanganyika Territory.* By Frank Oates. Bulletin 4. Tanganyika Geological Survey. Dar es Salaam. Price 5s. Pp. 118.

*Hydrology of Lake Tanganyika.* By C. Gillman. Bulletin 5. Tanganyika Geological Survey. Dar es Salaam. Price 3s. Pp. 27.

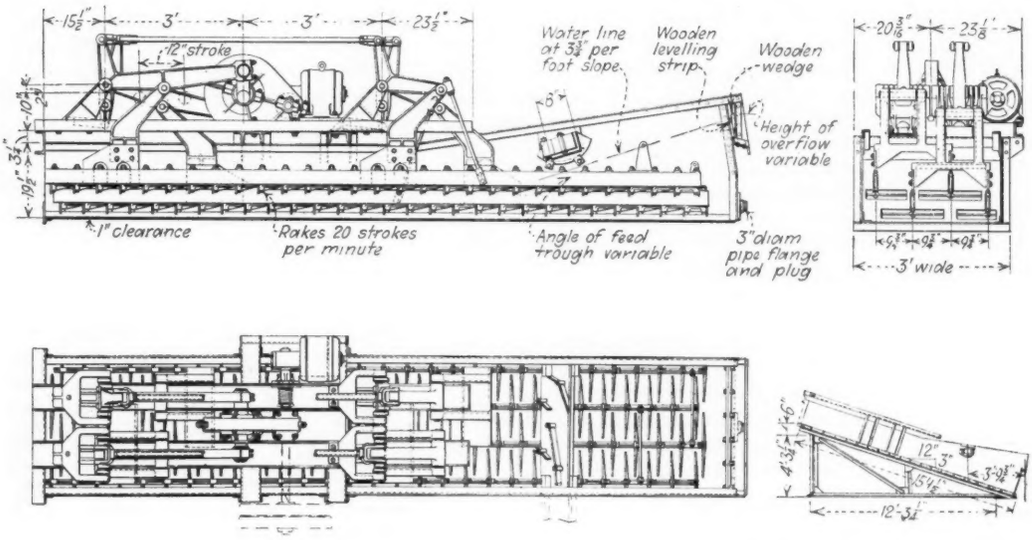
# Improved Classifier Efficiency Claimed

**Greater Capacity, Cleaner Sand, Denser Overflow**

Desirable features to be sought in a classifier include the ability to run constantly and smoothly and to permit constant withdrawal of oversize. It should also be compact and cost little to maintain. A new machine of this type, developed by General Engineering Co., and known as the Geco double-acting classifier, is considered important because in its design surging has been almost entirely obviated and the closest approach has been made to continuous delivery of oversize. The construction of this machine is shown in a sketch. Obviously, the improved distribution of the load should insure smooth running and less wear and tear.

The new classifier has reciprocating rakes, as shown. Two sets of blades act independently, one set moving up the slope as the second is traveling back over it. When the second set arrives for the beginning of a stroke, it descends and its blades pass between those of the first set, which rise for their return movement. Thus the raking movement is practically continuous, the sands not being allowed to slip back and the pulp being continuously and uniformly agitated. In this way capacity is said to be increased, a cleaner sand made, and a denser overflow obtained. The design allows a steeper rise, which facilitates the return of sands to the mill and reduces the floor space required. The slope is adjustable.

Rake blades are strongly attached to their respective stringers, each by a single bolt, this facilitating replacement. Drip pans are provided to prevent lubricating oil dripping from the rake mechanism into the tank.




**New double-acting rake classifier. Plan and elevation**

# Steel Grinding Media

*Dipl. Ing. P. Dransfeld*

Use of precision steel balls in ball bearings is well established. Less known is the application of forged steel balls in ball mills, for coarse and fine grinding alike.

The characteristics considered most important in such grinding media are resistance to wear and high grinding efficiency. These properties are attained by forging balls from steel of natural hardness, using the proper heating process in the forging to impart to the balls homogenous, fine-grained structure throughout. The tensile strength should be 90 to 100 kg. per square millimeter (130,000-140,000 lb. per square inch) prior to heat treatment.

Grinding media that by water or oil quenching have been brought to the strength of steel of natural hardness, or even higher, up to 150 kg. per square millimeter (200,000 lb. per square inch) show neither great resistance to wear nor high grinding efficiency. The explanation for this lies in the fact that such media do not abrade, but slide through the material being ground. They have also a great tendency to fracture and disintegrate in the mill.

A grinding medium's resistance to wear must not be unduly increased without taking into consideration the hardness of the mill lining. As renewal of the lining is far more costly than replacement of grinding medium, the lining should possess a much higher resistance to wear. Selection of lining and grinding medium with this fact in view is essential for economical operation.

Almost every conceivable shape of grinding medium has been tried, even cubes (dice). Extensive experiments have shown that the ball or roller-shaped medium insures the most favorable results.

Steel balls and cylpebs (short pieces of cylinder steel) for grinding mills are made by Klockner-Werke A.-G., Osnabruck, in sizes for balls from 30 to 500 mm. diameter (1¼ to 20 in.), and for cylpebs from 12 to 50 mm. diameter (½ to 2 in.); cylpebs are used instead of balls below 30 mm. diameter. The charge of steel before being forged into shape is analyzed and tested for chemical composition, tensile strength, elongation, and Brinell hardness; the grain is studied by metallographic methods, and resistance to wear and impact strength are determined in a 5-ton testing machine. In addition, control tests are made in a small grinding plant.

### Another New Classifier

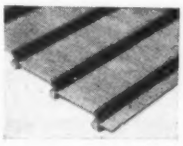
Announcement is made by Colorado Iron Works Co., Denver, Colo., that they have been developing a new type of Akins classifier built for large overflow capacities or where extremely fine overflows or high densities are required. The installations made to date in ore-

dressing plants are said to have done well. The new type is designated as the duplex submerged-spiral machine. Because the lower ends of the spirals are submerged, it is said, no agitation or disturbance takes place near the overflow weir, so the weir can be extended up both sides as well as across the overflow end of the tank. Ample sand raking capacity is afforded for large circulating sand loads, inasmuch as the spirals rotate from the bottom towards the center so that each conveys its load against a moving mass of sand from the opposite spiral, the whole mass moving up the center of the tank and leaving an effective drainage channel down each side.

### New Screening Devices

When screening splintery or elongated material, both mesh and slotted screen surfaces tend to clog. To avoid this difficulty, a stepped wedge-wire slit sieve or screen, known as the Rima, has been devised and is being handled by Abbe Engineering Co., New York. Primarily it is intended for desliming and dewatering fine coal 0-3 and 0-12 mm. in size respectively but can be used on other similar material. The individual wires are bent to form steps on the screen surface, as illustrated, the head of the wire being slightly narrower as it nears a step. Over these steps the material falls, continually turning over, this movement keeping the slits from clogging.

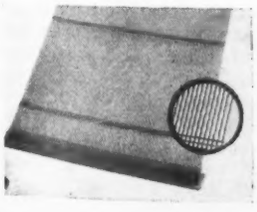
Another type of screen surface, also introduced by the firm mentioned, is the so-called harp-screen, made from specially waved spring wires running lengthwise and maintained at certain distances by a few cross wires, there being a long succession of free crimps between each pair of cross wires. Long slit openings are thus provided. To insure a stiff surface, strong longitudinal tension is provided by special devices. The harp-screen is said to be specially adapted for vibrating screens. It is self-cleaning. Working on coal, it has given a capacity of 30 tons per hour,



**Stepped wedge-wire slit screen.**

compared with 16 tons obtained with ordinary spring steel mesh.

Stepped perforated plates, in interchangeable sections, and with holes of 5 to 70 mm. width, are also being made.



**Section of harp screen. Crimped wires shown in circle.**

### Saves Coarse and Fine Gold

W. H. Harris, Imlay, Nev., has given further information regarding his dry washer, described in the April issue. The 50-mesh screen placed 1 in. above the riffles is intended to serve simply as a baffle to keep gold from blowing off the riffles. The gravel fed does not pass through it or over it. Instead, the gravel is screened into the bin above the riffles through a ¼-in. screen set at an angle of about 60 deg. on top of the machine. Screen undersize passes over the riffles and under the baffle, both of which are set at 50 deg. to the horizontal. The earlier article referred to seems to have given many would-be users the idea that the washer would save only minus 50-mesh gold.

The double model illustrated weighs only 50 lb., compared with 40 lb. for the single machine.

**Drive side of Harris dry washer, double model. Note little drawers, at bottom of fan boxes, to catch fine gold. White object at left is the dust chute.**

### Improved Centrifugal Pump

A line of centrifugal pumps having an open impeller of correct hydraulic design and in which end thrust has been eliminated, has been developed by Roots - Connersville - Wilbraham, Connersville, Ind. This is the so-called Hayton line. All hydraulic balancing devices required with other types of impellers have been discarded. The impeller used operates between accurately machined side walls, eliminating wearing rings and leakage of water back to the suction. Heavy-duty anti-friction bearings are among the features. The open-type impeller is said to be well adapted for handling corrosive water, because it can be made of chrome iron or other acid-resisting metal. The company claims that many installations have proved that when handling acid water, this impeller will outwear five impellers of the ordinary kind and will maintain its efficiency throughout.

**Jack P. Bonardi,** for 12 years associated with the Mine and Smelter Supply Company, first in charge of the Assay and Chemical Department at Denver, and later for 10 years in New York City as sales manager and manager of the Eastern office, has opened an independent sales and engineering office in the General Motors Building, 1775 Broadway, New York City, under the name of Mining and Industrial Equipment Co. In addition to conducting a general mine and mill equipment business, Mr. Bonardi is also acting as direct Eastern sales representative for Great Western Electro-Chemical Company, Pan American Engineering Corporation, E. D. Bullard Co., E. H. Sargent & Co., and others. Associated with him is H. M. Jennings, for 9 years with Canadian Allis-Chalmers, Ltd., as sales engineer in charge of the Quebec and Montreal district.

The Gunitor Co., Elkhart, Ind., has been incorporated to produce a line of machines for pneumatic application of cement, concrete and refractory materials. C. L. Dewey will be president and manager.

Manganese Steel Forge Co., Philadelphia, Pa., has acquired the entire business and assets of the Audubon Wire Cloth Co., as of May 1 last. The business will be conducted by the Audubon Wire Cloth Corp., a new organization wholly owned by Manganese Steel Forge Co. L. W. Jones will be president.

## BULLETINS

**Power Transmission.** Poole Foundry & Machine Co., Baltimore, Md. Catalog 33-RG. Reduction gears. Pp. 36.

**Photomicrographs.** Bausch & Lomb Optical Co., Rochester, N. Y. Pamphlet, "Low Power Photomicrography with the Micro-Tessar." Pp. 8.

**Explosives.** Hercules Powder Co., Inc., Wilmington, Del. Bulletin, "The Growth of a Modern Hercules." A sketch of the growth and operations of the company. Pp. 40.

**Corrosion Protection.** Bulletin entitled "Duozinc," covering an improved process and product for protecting iron and steel against atmospheric corrosion. E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Pp. 48.

**Conveying.** Robins Conveying Belt Co., New York, N. Y. Bulletin 82. Robins belt conveyors, a handbook for designers. Pp. 100. Also a 4-page pamphlet describing Robins belt trainers for keeping belts straight.

**Electrical Equipment.** Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Bulletin L20499. Combination line starters for squirrel-cage and wound rotor induction motors. Pp. 2. Also Bulletin L20581. Starting and speed-regulating rheostats for direct-current motors. Pp. 4. Also Bulletin L20570. Rectox battery chargers. Pp. 4.

# *Trends and Developments In the Industry*

## Administration Expects Early Submission Of Basic Code by Mining Industry

MINING, with its various subdivisions, is one of the larger industrial groups from which codes will be early expected by the National Recovery Administration. Questions presented to officials of the Administration on behalf of *Engineering and Mining Journal* bring out the following points, which are to be considered in the formation of the codes that will be expected.

Primarily, the Administrator, General Hugh S. Johnson, asks from the large mining industry groups—formed already or to be formed under the new law—a broad general industry code, a "basic code," as it is termed. This should settle the questions of minimum wages and maximum hours, the wages being scaled according to the costs of living in different mining regions; for instance, New Mexico will have a lower base wage than Montana. It should touch on conditions of employment, and it should also provide, in the words of General Johnson's important "Bulletin No. 2" on the subject of basic codes, "such means as each industry may find necessary to protect its constructive and cooperating majority from the wasteful and unfair competition of minorities and recalcitrants." Refinements of the basic code will be considered later, upon application of the associations.

### Grouping of Units Essential

Within the industry, all its various groups and branches may, and should, without delay, draw up and submit codes of procedure dealing with employment conditions and with trade practices, and too much emphasis cannot be directed to the fact that the grouping of small units of the industry, the means which they adopt to solve their difficulties and to find a way to act jointly, is up to the industry, not to the government. Under the new law, the anti-trust laws have been suspended, and, if the mining industry cannot get together now, its plight is impossible. The government will not prescribe a code at once, but there is no gainsaying the fact that the law has teeth in it, and that if an industry fails to solve its problems and get men back to work—jobs are the motivating elements in the new law, above all else—it will find a code prescribed for it, or at the worst find the activities of each member of the industry the subject of licensing. This will not be resorted to excepting under great difficulties, and as a last resort, but it is there, and there to be used.

Every industry coming to Washington points out the difficulties which force its organization into groups and associations. This is true almost without exception, and the mining industry, with its several units, is no different in its intricate problems than a dozen others. If the necessity of raising wages and shortening hours threatens to cause the operating units of the industry to rob its oreshoots and return to rat-hole mining to reach low production figures, it is up to the industry and not to the government to correct the situation. Price agreements and even allocation of production (under limitations) are permitted, and under the law if the majority (75 per cent or above, in volume and number) of the various units unite under a code, the recalcitrant units can be forced into that group or suffer the penalties of the law. Those penalties ($500 fine for each violation) can be invoked with astonishing ease, and, with that power, the difficulties of organization seem to Washington to disappear, even if those difficulties include shortage of raw material or scrap or any other of the myriad problems which are obvious to every member of the mining and metal fabricating industry. The old days are gone, and the new methods are to be found first in the National Industrial Recovery Law and second in the various pronouncements under it, notably the statement of President Roosevelt (Bulletin No. 1) and Bulletin No. 2, giving directions for the preparation and submission of the new codes.

As to the problem of making many units of the industry, no objection is made to this, but a demand will doubtless be expressed for some form of basic code for the metal mining group, and under that, many subdivisions grouped by classes.

A continuous flood of questions has been addressed not only to the officials of the Industrial Recovery Administration but to officials of the Bureau of Foreign and Domestic Commerce, to the Chamber of Commerce of the United States, to the National Association of Manufacturers and to the White House itself. The answers to these questions are not yet official; many of them will be changed, in fact, as time goes on, but no truer picture can be presented of what Washington knows about the National Industrial Recovery Administration than that afforded by these questions and the answers which have been given them. The following selections, made from a mass of material of this character, pertain to minimum wages and maximum hours, production quotas and industrial problems, and price fixing.

### Minimum Wages and Maximum Hours

Q. What factors are to be considered in the fixing of wages? A. No fixed figure as yet. The actual policy is in process of evolution. The Chamber of Commerce, Department of Labor, American Federation of Labor, all can help. The Labor Advisory Board of the Administration will pass on the provisions and assist the Administrator at hearings. A minimum set rate for the lowest class only, is deemed feasible at present. Regional differences will be allowed, depending on the cost of living.

Q. May or should an industry use levels of any previous year as a basis for restoring wages, costs, and sales prices? If so, what year is to be used? A. No. But it would be advisable to consult the Administrator and the Department of Labor in specific cases.

Q. Should an industry formulate a trade code if its hours and wages are fair and it seeks no favors of the Government? If it does not form a code what happens? A. If present hours of labor and wages are mutually satisfactory and fair, they can be made the basis of the suggested code. The Government will not at first coerce industry but will marshal the full power of public opinion and persuasion by appeal to reason, common sense and the self interest of industry.

Q. If an industry submits a code, can it organize a company union and oppose outside union control? A. Company unions may be organized, but no employer shall force any employee to join such a company union as a condition of employment, nor may an employer interfere with voluntary association in or with any group or union of the employee's own choice. But the Administrator's labor policy will be based on fairness and common sense, with justice to all and recognition of the rights of all.

Q. Is it necessary to consult labor in drafting a code containing hours of labor and minimum wages? A. It is not necessary but it would certainly seem advisable to consult the Department of Labor and the Administration's Labor Advisory Board.

Q. Can an industry work out hours of labor on a yearly average? For example, should the code provide for peaks of 44 hours a week with 32 as the annual average? A. Preferably on a six months' average. A 32-hour average with 44-hour peak seems the favored goal. It will largely depend on individual industry agreements with the Administrator.

Q. Does the minimum wage apply only to skilled labor? A. Likely to lowest class only, but wages of all labor and small salaried classes must be correspondingly protected. Variations for skill, experience, and other qualifications will depend on "common sense and common justice."

**Production Quotas and Industrial Problems**

Q. What is the Administration's policy regarding production quotas? A. If acceptable to a substantial majority of the industry and done to protect present employed labor, production quotas will be allowed after due hearing and full examination.

Q. May an industry propose to close some plants in an industry where overproduction exists, and if so what basis should be used in determining the plants to be closed? A. Generally speaking, no overproduction exists. The overproduction is in capacity. Agreements not to sell below cost will automatically exclude from operation unnecessary plants until such time as excess capital charges have been wiped out by change of hands. In other words, agreements not to sell below cost will automatically close high-cost plants in those industries where an excess of capacity actually exists.

**Price Fixing**

Q. What is the policy regarding price fixing? A. Price fixing is not now encouraged. Let the purchasing catch up with the cost of living. Some fixing will be inevitable, but industry will be asked to bear the initial cost of the increased cost of production. Purchasing power must catch up with present costs. Price control will be the first step.

Q. Will price fixing be permissible under the law? A. Price fixing will be frowned on except in special cases. Price control, to prevent below-cost selling, is desired and will be encouraged.

# Gold-Mining Activity Continues

## Further Interest Is Taken in Old Properties in Several Districts of the United States—Immediate Outlook for a Premium on the Metal Unfavorable

ACTIVITY in the gold-mining districts continues to expand, with many old mines and workings being reinvestigated as additional sources for the profitable recovery of the metal. Operations of this character are assuming particular importance in California and Nevada. On pages 296-7 of this issue, J. B. Huttl, in his article "California Gold," describes some of the larger enterprises in that state, and in the paragraphs below details are presented of other such ventures in both of these states.

The immediate outlook for a premium on gold in the United States is distinctly unfavorable. Although strenuous efforts have been made to secure a ruling from the Treasury Department that would permit newly-mined gold to be sold at the world price, the administration has definitely stated that no such provision is now under consideration. Relative to the surrender of mine output of gold, the Secretary of the Treasury has ruled, "Executive order of April 5 requires delivery of all gold bullion produced by miners and refiners except 'stocks of gold in reasonable amounts for the usual trade requirements of owners mining and refining such gold.' Accordingly all miners and refiners must deliver all gold bullion in the continental United States now owned by them except such reasonable amounts not to exceed the amounts which prior to April 5, 1933, it was their practice to maintain in stock. The provisions of such executive order requiring delivery to a Federal Reserve Bank, etc., are not construed to exclude delivery to a United States Mint or Assay Office."

The aforesaid executive order has been held by the Treasury Department to apply (1) to gold in any shape or form, be it in alloys, bullion, coins, or otherwise; (2) to both continental United States and foreign possessions. On ores carrying recoverable amounts of gold, and on concentrates carrying gold, the rule of reason will prevail; if gold constitutes a material part of the value the embargo will apply. In this last instance, the department is said to contend that determination of the percentage that gold might represent in the total value of the ore or concentrate would be a question of law and one for the courts to decide; disposition of the department officials is held to be that ores and concentrates would be allowed to move as in the past, but that any shipments obviously being made to circumvent the embargo on gold would be challenged.

Gold production in the two leading gold-producing countries—South Africa and Canada—improved during May, but this increase over the output of the preceding month was, in each instance, relatively small, reflecting principally the effect of the greater number of working days in May. As shown in the accompanying table, South African production totaled 944,000 oz., compared with 895,000 oz. in April. Canadian output in May was 239,000 oz., as against 237,000 oz. in the preceding month. United States output, on the contrary, declined by 4,000 oz. in May, continuing the downward trend shown in the statistics for the previous month. This falling off in output is said to largely result from the aforesaid unfavorable outlook for a premium on gold in the near future.

**World Production of Gold**
*(American Bureau of Metal Statistics)*

| | In Fine Ounces | | |
|---|---|---|---|
| 1933: | March | April | May |
| United States (a) | 252,000 | 189,000 | 185,000 |
| Canada | 260,000 | 237,000 | 239,000 |
| Mexico | 51,000 | 44,000 | (f) 48,000 |
| South America | 59,000 | 68,000 | 63,000 |
| British India (e) | 30,000 | 28,000 | 27,000 |
| Japan (e) | 36,000 | 34,000 | 35,000 |
| Australia (b) | 87,000 | 92,000 | 94,000 |
| South Africa | 951,000 | 895,000 | 944,000 |
| Belgian Congo | 21,000 | 21,000 | 21,000 |
| Rhodesia | 50,000 | 54,000 | 52,000 |
| British West Africa | 27,000 | 27,000 | 27,000 |
| Russia (c) | (f) 160,000 | (f) 160,000 | (f) 160,000 |
| Elsewhere (d) | (f) 70,000 | (f) 70,000 | (f) 70,000 |
| Totals | 2,054,000 | 1,919,000 | 1,965,000 |

(a) Includes Philippines. (b) Includes New Zealand and New Guinea. (c) Chiefly Siberia; 1933 estimated at average rate of 1932. (d) Includes West Indies, Central America, Europe, and Asiatic and African lands not separately reported; estimated. (e) Principal mines; nearly complete. (f) Conjectural.

**California**

Good progress is being made by Hoge Development in rehabilitating the Lava Cap properties near Nevada City. The old shaft is to be deepened to 800 ft., preparatory to a comprehensive plan of development work. Considerable high-grade ore has been uncovered in the old workings. The company plans to install a mill before the end of the year.

A high-grade pocket has been found in the Diltz mine, near Mariposa. This find constitutes the third large pocket unearthed in less than a year.

Preliminary development work completed at the Nashville mine of Montezuma-Apex Mining includes dewatering of the Nashville shaft and a permanent connection between the Nashville and the adjacent Montezuma mine. About 54,000 tons of high-grade ore is estimated to be blocked out in the Montezuma.

Central Eureka Mining, operating at Sutter Creek, reports the discovery of an orebody 6 ft. in width on the 2,100-ft. level. It is the upward extension of the orebody recently met on the 2,300-ft. level.

Milling operations have been suspended at the Beebe mine at Georgetown, pending completion of changes made on the Hadsel mill, and rearrangement of the mill flowsheet. Fifteen men are employed at the Alpine mine, Atolia subsidiary, under the direction of P. R. Bradley, Jr., in dewatering the shaft to the 400-ft. level and in general development work. A 45-ft. headframe and electric hoisting equipment have been installed recently. Extracted ore is trucked to the Beebe mill.

Satisfactory results are being obtained by Canyon Creek Dredging, operating a 1,500-yd. dredge in Canyon Creek near Georgetown. The company is controlled by Peake Engineering, of San Francisco. Proven dredging ground is 2 mi. long.

In the Arrowhead district, Death Valley Gold Mines plans to start its 75-ton flotation plant on a 16-hr. basis after increasing its supply of water. At the same time, the company is drifting north on the north-south vein on the 300 level to prospect a promising territory and to develop sufficient water for operation of the mill 24 hr. a day. On the 200 level, the company is drifting east to reach the Brown vein. Six hundred feet of drifting, according to estimates, remain before the objective will be reached.

### Nevada

A revival of mining on the Comstock lode has started several new projects, and ore of milling grade is being developed over wide areas. On the north end of the lode, at Virginia City, the upper parts of the veins are being explored for orebodies that received little attention in the bonanza days. Arizona-Comstock, which pioneered in this work, is operating a 150-ton flotation mill successfully, mining ore from the Savage, Chollar, and Potosi mines, to a depth of 580 ft. This is the first application of flotation to Comstock ores, although flotation cells are installed at the Recovery custom mill at Silver City, following amalgamation plates.

In the upper section of the Comstock lode gold is the predominating metal, carrying 80 to 85 per cent of the total mineral value. That section of the lode known locally as the Ophir Croppings, of great width, is being explored with success by the Ophir and Consolidated Virginia companies, operating on joint account. Consolidated Virginia & Andes, adjoining on the south, is retimbering the 500-ft. Andes vertical shaft, with the object of exploring the lode in a section that was developed but not mined in the early '70s, before the Big Bonanza was struck by Mackay and Fair.

At Gold Hill, a mile or more south of Virginia City, plans have been drawn to reroute the Virginia & Truckee railroad where it crosses the noted old Crown Point mine, to permit the Comstock Tunnel company to mine a large body of ore, developed on two levels to a depth of 250 ft. Comstock Tunnel, which owns the Sutro drainage tunnel, is to pay the cost of moving the railroad, estimated at $40,000, to be done under supervision of V. & T. engineers.

South of the Crown Point mine, about 1,000 ft. from the Consolidated, Chollar, Gould & Savage is building a 50-ton flotation mill as a test plant. Equipment consists of a crusher, Hardinge ball mill, Dorr classifier, and Kraut flotation cells.

On the Brunswick lode, a little more than a mile east of Virginia City, Western Empire has acquired the Keyes and Monte Cristo mines. A winze is being sunk from the 400-ft. level of the Keyes on 7 ft. of mill-grade ore, and a drift is being driven south on the same level, to connect with old workings in the Monte Cristo. Both mines have produced rich ore to a depth of 300 ft. Western Empire is operating the Milwaukee mine at Silver City and recently completed milling 400 tons of ore from the Keyes and Milwaukee mines at the Recovery custom mill.

If success attends the work of the Ophir and Consolidated Virginia, and the Andes, both companies plan to build mills of 300 tons' capacity. Three shifts are employed at most of the mines.

### Montana

One of the foremost gold strikes in Montana in a number of years was made recently at the properties of Basin Goldfields, in the Pole Mountain district, one mile from Basin, Jefferson County. The strike was made in the No. 1 or the East tunnel, about 115 ft. from the portal, in what is believed to be a virgin vein, about 3 ft. wide. So far, this ore has been drifted on for a distance of 15 ft., and is being sacked for shipment. The veins are quartz with granite walls, the ore containing from 1 to 8 per cent lead, in the form of carbonate. Later on the company plans to install electric power and modern machinery, and to drive a crosscut tunnel, which will tap all the veins on the property at a depth of 200 ft. below present workings.

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## Hollinger Officials to Erect 500-Ton Mill

Hollinger officials have announced their plans for the 500-ton mill which is to be erected to test the merits of the Young-Davidson gold property at Matachewan in northern Ontario. Open-pit mining is to be used in the first instance, followed by hand-picking of as much barren rock as can be selected. Hollinger milling practice is to be followed, namely tabling of ground ore to remove sulphides, cyaniding of the remainder, and re-grinding and separate cyaniding of the concentrate. The deposit consists of porphyry intersected by irregular quartz veins and stringers, with maximum dimensions of 400 ft. by 1,000 ft. Hydroelectric power is available.

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## Oro Grande Completes Mill

Oro Grande, in the central Manitoba gold field, has completed its 75-ton mill, which is to be fed at about half capacity with ore from the dump and from current development. The vein is partly developed to a depth of 125 ft., and milling will keep pace with mine development. The plant is steam-driven.

**Kanakas, New Guinea natives, box sluicing on Koranga Creek, below the Golden Ridges, on the holdings of New Guinea Goldfields. Under the ruling of the League of Nations, only Kanakas may be employed as common laborers.**

*Courtesy of Roland Blanchard*

# *Industrial Recovery Expands in Many Mining Regions*

## Various Trade Associations Extend Their Cooperative Efforts With the Government Toward the Formulation Of a Basic Code

WAGE increases and expansion in industrial activity are mentioned in practically all reports coming in from the various mining districts. Among the various trade associations of the industry, strenuous efforts are apparently being made to develop the framework on which a basic code can be built. Preliminary surveys that relate to wages and hours of employment have occupied much early consideration on the part of each of these agencies, but as soon as these data have been compiled, the understanding is that preparation of a proposed code will be undertaken. In the meantime, active cooperative effort of the various companies and associations with the objectives of the government finds expression in the increase in operations and advances in wage scales that have recently been announced. Brief references are made in the following paragraphs to some of the more important evidences of the upward turn that has developed lately in the mining industry.

### . . . UTAH

UNITED STATES SMELTING, REFINING AND MINING has completed the foundations for its new lead refinery at Midvale, and erection of the structural steel has commenced. Regular shipments are being made from the U. S. mine at Bingham, and development has been in progress at the Lark properties of the company.

PURCHASE OF THE GRAND CENTRAL PROPERTY in the Tintic district from Chief Consolidated for $300,000 by American Smelting and Refining forms the second large property acquisition in Utah by the company during a 30-day period, the other being in the Bingham district. Acquisition of the Grand Central mine gives A.S.&R. a reserve of low-grade siliceous ores estimated at 600,000 to 1,000,000 tons, which can be used as conditions at the Garfield smelter justify.

IN ITS BINGHAM HOLDINGS, A.S.&R. has started sinking a three-compartment shaft from the Armstrong No. 2 tunnel, about 1,000 ft. below the surface, to prospect the A, B, C, and possibly the D limestones, never developed previously in this new territory acquired by the company. Depth of the shaft is nearing 100 ft., with progress averaging 5 ft. daily. The company plans to put the shaft down about 1,800 ft. and do several thousand feet of drifting in Boston Consolidated Sulphide and Utah Metal & Tunnel holdings recently acquired.

ACTIVITY AT BAUER is represented by the shipment of a carload of ore daily from the Bluestone property of W. F. Snyder and Sons, operating from the Honerine tunnel at a point about 2 mi. from the portal. Effective June 15, the wage scale of the crew of sixty men was increased 25c. a shift.

BUILDING OF A POWER LINE from Ophir to the Manning plant of Manning Gold Mines near Mercur has been completed and all of the heavy machinery for the cyanide plant put on the ground. By Aug. 1, expectations are that the 500-ton plant can begin treatment of the 450,000-ton tailings dump. The foundation has been completed and construction of the building started.

### . . . NEVADA

GRADING IS UNDER WAY and machinery is being assembled for two 50-ton units of a mill, being built in Rosebud Canyon, northern Pershing County, by American Milling & Mining. W. D. O'Brien, mining and metallurgical engineer of San Francisco, is president and general manager. The process to be used is amalgamation followed by flotation. Power will be supplied by two Y-type Fairbanks-Morse diesel engines. Minerals Separation flotation machines will be used. One mill will run on ore from the company's properties at Rosebud, the other on company and custom ore from Scossa. At Scossa, the company has purchased the Noble mine and is installing a larger hoist and air compressor. Three mines are operating, the Noble, Red Top and Dawes, and are in condition to send ore to the mill. The mill site is midway between Scossa and Rosebud, 3½ mi. from both camps. Gold is the principal metal in the ore, with a little silver at Rosebud.

RANIER INVESTMENT AND MINING has taken an option on the Ramsey Comstock mine in Lyon County, 35 mi. east of Reno, and is retimbering the 480-ft. vertical shaft from the 360 level to the bottom, preparatory to cleaning out the drift on the 460 level for sampling. Ramsey is 15 mi. northeast of Virginia City and the formation is similar to the Comstock lode. Gold is the only metal in the ore.

GOLDFIELD CONSOLIDATED OF NEVADA, according to reports, is to again engage in gold mining, if a suitable property is found. On June 2, Goldfield Exploration, wholly owned subsidiary, sold its interest for $700,000 in Base Metals, Field, B. C., to Frank Eichelberger.

CHURN-DRILLING has been started at Lime Point on property developed by Arthur Thomas, of Salt Lake City, and Thomas S. Wilson, of Ogden, by James W. Decker, of New York, under the direction of F. Huntington Clark, to ascertain the extent of mineralization in the highly altered porphyry and limestone formation, which contains gold.

### . . . MICHIGAN

AN INDICATION of some improvement in the copper situation was seen in the recent action of Copper Range in restoring the schedule of wages that was in effect before May 1. June wages were paid on the new basis and an adjustment of May wages will be made so that employees will not have any loss. Several wage reductions had been made by the company during the course of the depression. The feeling in the industry in the Michigan district is that a distinct change for the better has occurred and that the trend in the metal market will be upward. Every effort has been made to give as many men employment as possible at wages the companies could afford, and costs have been greatly reduced in all departments to enable such mines as remained open to continue operations.

HEAVY SHIPMENTS OF COPPER have been made from the Calumet & Hecla and Copper Range smelters in the Michigan district. Metal has been going out by boat and rail during the last few weeks, evidencing a real demand. According to estimates, 12,000,000 lb. of Copper Range and Mohawk copper have been shipped in the last month. Although a considerable volume of copper has been moved, stocks on hand are still large. Movements of metal, however, are the most encouraging in many months, and are taken as evidence that the copper mining industry has definitely "turned the corner."

### . . . CALIFORNIA

NATIONAL EXPLORATION, a New Mexico concern, operating the Densmore property near Sonora, has developed sufficient ore to justify the erection of a 100-ton mill, arrangements for the construction of which are being made. The Densmore mine embraces a group of properties covering territory about 1 mi. in length and has underground workings aggregating 3,000 ft. Work on the mill is to be started soon.

CENTRAL TAILINGS, managed by Hamilton, Beauchamp & Woodworth, of San Francisco, is erecting a new 600-ton plant near Sutter Creek for re-treating the tailing of the Central-Eureka mill. An expenditure of $70,000 is in-

volved. The plant, a replica of the Amador Metals Reduction plant at Jackson, will be in operation early in September.

GOLDEN CENTER MINING, operating at Grass Valley, expects to have its new power plant in operation within 60 days. The power house equipment consists of a 500-hp. McIntosh-Seymour diesel engine and low-pressure steam boilers utilizing the exhaust gases of the engine. Additional work recently undertaken at the mine includes driving of a 700-ft. tunnel to explore the Scotia holdings of the company.

RANDSBURG ASTER GOLD, engaged in re-treating the tailings of the Yellow Aster mill in a 250-ton plant, has started work on a new 150-ton cyanide plant, according to reports from Randsburg.

AT THE CAMP OF ARROWHEAD, San Bernardino County, W. F. Snyder and Sons are sinking a shaft to the 200-ft. level, where the vein will be followed to the andesite. Depth of the shaft is 170 ft. A new hoist is being installed. On the Patsy Tony ground, two miles west of the Arrowhead Gold Mining Co.'s shaft, a shaft is being put down on a high-grade vein.

### . . . IDAHO

A NOTICE POSTED RECENTLY at the Morning mine and mill of Federal Mining & Smelting, at Mullan, informed 500 men employed there that they will keep on working instead of being laid off July 1, as they had expected. The employment is the result of the rise in prices of silver, lead, and zinc, and the company, according to reports, hopes that still higher metal prices will soon justify resuming operations at the Page mine, near Kellogg. Wages were recently increased 50c. a day at the Morning mine and mill.

### . . . MONTANA

BUTTE COPPER & ZINC, of which Anaconda Copper Mining is the largest stockholder and on which it holds a lease and working agreement until 1941, will start to produce zinc ores early in August. At present 85 men are working putting the property in shape to produce. Recently Butte Copper & Zinc's Emma mine produced 800 tons of high-grade "pink" manganese ore, which was shipped to a steel manufacturer in Ohio. The Orphan Girl mine of the Anaconda Copper Mining is about ready to produce zinc ores. When these two mines are in production, about 1,000 men will be given work in the Butte district. Five sections of the concentrator at Anaconda will be run and five units of the zinc refinery at Great Falls, giving employment to a large number of men. At the three points local labor only will be employed, and no outside labor will be considered until that available locally is fully employed.

ARDSLEY BUTTE MINES will start shortly unwatering its 500-ft. shaft in the southwest or Ardsley section of the Butte camp. Before the price of silver slumped, this property, at which developments were of the sensational order, was one of the largest silver producers in Montana. The main shaft is on the Highland claim, about 1 mi. south of the Orphan Girl of Anaconda Copper Mining.

THE FLOTATION MILL of Bell Boy Gold Mining, in the Marysville district, Lewis & Clark County, will shortly start operations. The company has extended the main tunnel 1,400 ft. and opened three new veins, which have been drifted on for a distance of 1,600 ft.

VOSBURG MINING was recently incorporated in Washington to take over the workings of the Vosburg Syndicate in the Winston district, Broadwater County, which property has been shipping lead-gold-silver ore.

WICKES-CORBIN GOLD AND SILVER MINING, a Washington corporation, has taken over the Ariadne and Bee claims, known as the Gable group, near Corbin, Jefferson County. The property, which formerly shipped gold and silver ore, is opened by a 60-ft. shaft which will be sunk an additional 100 ft.

ROY MILLER, INC., owner of the old Jib properties at Basin, Jefferson County, expects to start work on re-treating the old tailing from the mill on the tract, beginning early in July.

### . . . ARIZONA

WENDEN COPPER, which owns the Wenden mine at Wenden, has acquired control of the Nellie Meda, a small gold mine situated 8 mi. north of Aguila, and is installing new equipment in preparation for development.

DENVER INTERESTS have acquired 100 acres of placer claims in the Weaver creek district 15 mi. north of Wickenburg, and are preparing to begin work with dragline equipment capable of handling 500 cu.yd. of gravel per day.

CROWN KING CONSOLIDATED MINING is planning development work at its property near Prescott, which, if successful, will result in expenditure of $200,000 for constructing a 150-ton mill and installing other equipment. The county is repairing the road to the mine. At the Gladiator mine, in the same district, the mill, operating on dump ore and tailing, is to be replaced by one of more modern type.

At Ajo, A. L. Richards has installed a new portable, 80-ton flotation plant for a 45-day trial run. If accepted, the mill will be used to treat the 40,000-ton tailing dump of the Sierra Pinta mine.

ADDITIONAL CAPITAL has been obtained for the development of the Bunker Hill mine at Tombstone by Tombstone Gold-Silver Mines. Drifting will be starting from the Empire shaft after it has been retimbered. A number of leasers have been working at the property since the company acquired it in February.

PHELPS DODGE announced in May that the number of working days per month at its Bisbee mines would be cut from 15 to 12, but on June 20, 900 miners who had been laid off on June 12 were recalled. According to the regular schedule they would not have reported back until July 10. Announcement has also been made that the corporation is preparing to spend $300,000 on the Junction shaft at Lowell during the next nine months. The shaft is to be deepened 1,000 ft. to a total depth of 3,300 ft.

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## International Nickel Increases Scale of Operations

International Nickel's operations have now been increased to 40 per cent of capacity to meet a renewed demand for nickel and Monel metal. The Creighton mine, closed since last August, has been reopened and will furnish 30,000 tons of ore a month to the Coniston smelter, where two of the blast furnaces have been blown in. The Frood mines' output has been raised to 100,000 tons a month, to supply two of the reverberatory furnaces at Copper Cliff. At the Port Colborne nickel refinery, five of the nine electrolytic units are in operation. The output of the copper refinery at Copper Cliff has been increased slightly, but ore is being selected from the Frood with a view to keeping the copper output down to a minimum. The company's total capacity for producing nickel in all forms is 180 million pounds a year and the current output is at the rate of about 75 million pounds.

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## Macassa Gold Mines Has Mill Under Construction

Macassa Gold Mines Ltd. has under construction a 200-ton mill to treat ore now developed on the levels between 2,000 and 2,475 ft. The mine has been developed from a drive, on the 2,475-ft. level, driven from the workings of the adjoining Kirkland Lake Gold property, but it is now served by its own 2,500-ft. shaft. While exploration at present is proceeding upwards with good results, diamond-drilling has indicated the continuation of the ore below the 2,475-ft. level. At the Kirkland Lake Gold mine, adjoining Macassa on the east, ore is being taken from the 5,050-ft. level, the deepest gold mining in Canada.

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## U.S.S.R. Lead Smelter Completed

Erection of the Chimkent lead smelter in the U.S.S.R. has been completed and the first Dwight-Lloyd unit installed. This smelter, according to reports of the Soviet, will have a capacity of 60,000 tons of lead a year.

# Sixteenth International Geological Congress Convenes in Washington July 22

**Many Foreign Geologists Will Participate in Technical Sessions and Field Excursions to Various Sections of the United States**

GENERAL SESSIONS of the Sixteenth International Geological Congress will be held in Washington, D. C., July 22-9, inclusive, after having been postponed for a year owing to general economic conditions. Normally, the congress meets every three years; the last previous meeting was held in Pretoria, South Africa, in 1929. Co-operation of the Geological Society of America in underwriting the expenses of the congress has made the sixteenth meeting possible at this time.

Prominent geologists from all quarters of the globe will attend the forthcoming congress; in fact, an advance list of those who have signified their intention of participating would seem to comprise the "Who's Who" of the geological profession. The names of more than 175 foreign geologists, representing 36 countries, appear in the list.

The general sessions will be preceded by a reception and luncheon at the American Museum of Natural History in New York City on July 21, to be given under the auspices of the Geological Society of America. A series of 33 field excursions has been arranged. These excursions, which cover most of the United States, consist of three groups: those that take place before the sessions, another group scheduled during the meeting, and a post-meeting group. The first group includes twelve short excursions from New York City, arranged by the New York committee, with C. P. Berkey acting as chairman. All the trips in this group, including the nine other more extended trips, conclude at Washington on the morning the general sessions begin. The group of eight excursions scheduled during the general sessions is confined to areas along the Atlantic seaboard, within a day's travel from Washington. Two transcontinental excursions, a trip to the glacial regions of the Central States, and another to the Lake Superior district make up the third group; these excursions begin at the conclusion of the general sessions. Members of the congress will receive a set of 30 guidebooks, in which the geological features of the various regions to be visited on the different excursions will be discussed in detail.

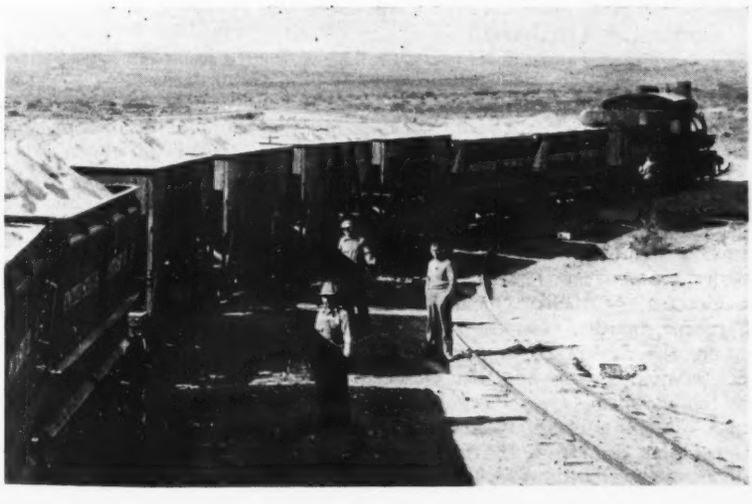
Topics that will be considered in the large number of papers to be presented before the congress are: Measurement of geologic time; batholiths and related intrusives; zonal relations of metalliferous deposits; major divisions of the Paleozoic era; geomorphogenic processes in arid regions and their resulting forms and products; fossil man and contemporary faunas; orogenesis; geology of petroleum; copper resources of the world. A volume, "Copper Resources of the World," will be published after the close of the general sessions and will be available to members of the congress at a reduced rate.

At the 1929 meeting of the congress the following committee on organization was chosen for the forthcoming sixteenth congress: Honorary president, Herbert Hoover; chairman of the committee, Waldemar Lindgren; general treasurer, Edward B. Mathews; general secretary, W. C. Mendenhall; assistant secretaries, H. G. Ferguson, M. I. Goldman. The executive committee appointed by the aforesaid organizing committee comprised the chairman, general secretary, and general treasurer, and H. Foster Bain, C. P. Berkey, E. DeGolyer, David White.

The plan of holding an International Geological Congress was evolved at the time of the Centennial Exposition of 1876, held in Philadelphia. At the first congress arrangements were made, with the co-operation of the Geological Society of France, for a second congress at the Paris Exposition in 1878. Succeeding congresses were held at intervals of three or four years in various countries of Europe, and in Mexico in 1906, in Canada in 1913, the United States in 1891, and South Africa in 1929.

**A trainload of potash salts leaves the mine of the U. S. Potash Company, near Carlsbad, N. M.—America's new source of this important mineral. The crude salts are shipped 15 mi. over a narrow-gage railroad to the company's refinery for the recovery of crystallized potassium chloride.**

*Courtesy of H. I. Smith*



## Improved Metal Prices Stimulate Mexican Operations

As silver prices have improved, the Cia. de Inversiones de El Oro, backed by American and Mexican capital, has restored to normal levels the pay of its workers in its mines in Sombrerete municipality, in Zacatecas, the Federal Department of Labor reports. During the past two years, this company, because of low silver prices, was obliged to put into effect two wage cuts. The department explains that the restoration of wages to normal standards will continue as long as the price of silver remains better than 30c. an ounce, but that if the price drops below that figure, the workers must accept a wage cut of 12 per cent, and, if the price drops to 25c. an once, they must expect reductions in their ranks.

Operations will be resumed soon in the metal-treatment plants of Cia. Min. de Peñoles properties in Coahuila state, and about 3,000 men will be employed as a result, according to information reaching the mines department of the Ministry of National Economy. Real del Monte y Pachuca has engaged 150 additional men for its El Alamo and Santa Gertrudis mines in Pachuca, Hgo., 117 of them being engaged for the latter. Greene Copper has resumed work on a considerable scale at its mines in the Cananea district, Sonora, the enterprise proposing to ship extensively to France and other European countries. The mines department of the Ministry of National Economy announces that in line with its recently announced policy to establish co-operative societies of miners to work abandoned mineral lands in order to stimulate the mining industry, its agents have begun organizing such societies in Jalisco state. The department announces that San Rafael Mining has installed a metal-treatment plant of 5,000 metric tons' daily capacity on its properties in Zacatecas.

Henri Jacot, former general manager

of the Huahuaxtla Mining, is arranging to unwater the old San Miguel mine near Huahuaxtla, Guerrero, work in which was suspended because of the outbreak of revolution in 1911. The mine produced fair amounts of gold, silver, and lead bearing ores. Jacot plans to build a plant at the mine after the unwatering, the size of which will depend upon the mine's yield. American Smelting & Refining has sent Thomas P. Clendenin, geologist, from its El Paso, Tex., offices to examine the La Mexicana silver mine in the Guanacevi district, Durango. Exploitation of amethyst quartz claims near Taxco, Guerrero, will be undertaken soon by the Cia. Explotadora y Talladora de Amatistas, recently organized by Mexican capitalists in Mexico City.

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## Mining Results Encouraging in British Columbia

Seasonal placer mining activity in the Cariboo district of British Columbia is in progress, hydraulicking operations having been started at a number of properties, including the Waverley, on Grouse Creek; the Lowhee, near Barkerville; and at many other smaller mines. The results of recent quartz mining developments in the area have been encouraging. In the main crosscut driven on Cariboo Consolidated's Island Mountain property, in which the Newmont is interested, numerous narrow veins have recently been exposed that carry satisfactory gold values. On Burns Mountain Burns Mountain Gold Mining has installed power machinery and development is making good headway.

The pilot mill on the property of the Cariboo Gold Quartz is making good recoveries, and a second cleanup made last month, representing 34 days' operations, yielded approximately 1,400 oz. At the recent annual meeting of the company an announcement was made that satisfactory financial arrangements had been effected to carry out a development program on a more comprehensive scale than heretofore, and to provide necessary equipment for large-scale operations. Meanwhile the company proposes to increase the present capacity of the mill to 100 tons.

Richfield Cariboo Gold Mines has been organized to develop a group of claims on Richfield and Bald Mountains' area on which good surface showings exist; and the Quesnel Quartz mine on Hixon Creek, located in 1881, has been acquired by newly incorporated Quesnel Quartz Mining.

Interest is being revived in the quartz veins of the Fairview camp of British Columbia, which area was the scene of considerable activity about 30 years ago. These veins, which occur in altered schists and quartzite, are traceable for several thousand feet. As a result of recent sampling, arrangements are being made in Vancouver for the organization of a company to acquire and operate the old Morning Star mine, together with the Black Diamond and other claims at the south end of the camp, in the expectation that large scale operations with modern treatment methods will prove profitable.

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## Eldorado Mines Produces Radium Salts

The radium reduction plant of Eldorado Mines at Port Hope, Ont., produced its first commercial radium salts last month, and a steady output will follow. The process used for making the radium-barium concentrate is the improved method worked out by the Department of Mines at Ottawa. A process is being perfected by the department for making from the uranium of the ore the salts used in the ceramics industry as pigments. Equipment is being installed in the Port Hope plant to treat the silver-radium ore from Great Bear Lake, which, as it differs considerably from the ore containing pitchblende only, requires a somewhat different process. In the meantime, equipment for the 50-ton silver concentrator is being transported to Great Bear Lake, as well as a second diesel power unit. The year's supply of oil, made at the small refinery of Imperial Oil on Mackenzie River, is being delivered.

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## Manager of Rhodesian Company Uses Plane to Visit Properties

London & Rhodesia Mining & Land has acquired a Fox Moth airplane, and a hangar is being erected. The company's interests are scattered over a large area in Southern Rhodesia. Digby Burnett, general manager and consulting engineer of the company, is an enthusiastic aviator, and by means of a plane he is able to keep in closer personal touch with the company's various properties than would be possible by other means.

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## Australasian Interest in Gold Continues Unabated

The remarkable interest in gold mining throughout all the states of the Commonwealth of Australia continues unabated. For the four months ended April 30, a total of 23 gold mining companies were formed in Victoria. In the corresponding period of last year 15 companies were formed.

Considerable progress has been made on the Cracow goldfield, Queensland, during recent months. On the Golden Mile mine, the 50-ton treatment plant has been completed and has had satisfactory trial runs. On the Golden Plateau a £12,000 contract has been let for a steel pipe line from the Dawson River. The pumping plant on the river will deliver 50,000 gal. of water daily, which will be sufficient for the needs of all the mining companies and the population of 650. A tunnel on the Golden Plateau is being driven a distance of 1,000 ft. to prove the downward continuation of the lode at a depth of 185 ft. below the surface. A treatment plant, with a capacity of 100 tons daily, is to be in operation by December.

The ten-head battery and treatment plant being erected on the Hannans Extended mine, Kalgoorlie, which was recently purchased by Broken Hill Proprietary, has been placed in operation. Capacity of the plant is 1,200 tons monthly. The company is developing the Enterprise mine from the 1,500-ft. level of the Great Boulder mine.

New Guinea Goldfields' milling plant is being extended to treat 150 tons daily; the additions) will be completed by August. Boring on the recently discovered alluvial area has commenced, and the first five bores have proved unpayable wash.

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## Mine of St. Joseph Lead Wins Safety Award

The Balmat zinc-lead-iron mine of St. Joseph Lead, at Balmat, N. Y., was the winner in the metal-mining group in the National Safety Competition of 1932, with one lost-time accident that caused two days of disability during 162,912 man-hours of operation, according to a recent announcement of the United States Bureau of Mines.

In the non-metallic group, first place was won by the Retsof rock-salt mine, at Retsof, N. Y., which is owned by Retsof Mining. This property operated 270,408 man-hours without a lost-time accident. It also received the highest award in this group in 1931.

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## Nova Scotia to Stimulate Gold-Mining Activity

To stimulate activity in the dormant gold districts that extend across Nova Scotia, Col. G. H. Harrington, Premier and Minister of Mines, has sponsored an act that provides for improved conditions in prospecting and mining. The unit area of $\frac{7}{8}$ acre has been changed to a mining claim of 40 acres. The leasing system, which permitted speculators to hold areas without doing any work, is changed in favor of those who will prospect and operate the properties. Hydro-electric power is made more readily available to gold mines by a guarantee against loss by the Nova Scotia Power Commission. Government assistance is authorized for underground exploration and the erection and operation of mills for testing purposes. Authority is given to set up an advisory board for gold-mining development, whose members, serving free of charge, will provide professional assistance for prospectors, investors and others.

# Daily and Average Monthly Prices of Metals

## June, 1933

### United States Market

| June | Electrolytic Copper: Domestic Refinery | Electrolytic Copper: Export Refinery | Straits Tin: New York | Lead: New York | Lead: St. Louis | Zinc: St. Louis |
|---|---|---|---|---|---|---|
| 1 | 7.650@7.775 | 7.500 | 40.750 | 4.100 | 3.950 | 4.300@4.350 |
| 2 | 7.775 | 7.550 | 41.125 | 4.100 | 3.950 | 4.300@4.350 |
| 3 | 7.775 | 7.675 | 41.250 | 4.100 | 3.950 | 4.300@4.350 |
| 5 | 7.775 | Holiday | 41.100 | 4.100 | 3.950 | 4.300@4.350 |
| 6 | 7.775 | 7.650 | 42.125 | 4.100 | 3.950 | 4.300@4.350 |
| 7 | 7.775 | 7.625 | 43.375 | 4.100 | 3.950 | 4.300@4.350 |
| 8 | 7.775 | 7.675 | 45.250 | 4.100 | 3.950 | 4.300@4.350 |
| 9 | 7.775 | 7.625 | 44.875 | 4.200 | 4.050 | 4.300@4.325 |
| 10 | 7.775 | 7.550 | 45.250 | 4.200 | 4.050 | 4.300@4.350 |
| 12 | 7.775 | 7.500 | 45.125 | 4.200 | 4.050 | 4.325@4.375 |
| 13 | 7.775 | 7.450 | 45.625 | 4.200 | 4.050 | 4.300@4.375 |
| 14 | 7.775 | 7.350 | 44.750 | 4.200 | 4.050 | 4.300 |
| 15 | 7.775 | 7.325 | 43.300 | 4.200 | 4.050 | 4.300 |
| 16 | 7.775 | 7.225 | 43.100 | 4.200 | 4.050 | 4.300@4.325 |
| 17 | 7.775 | 7.125 | 42.750 | 4.200 | 4.050 | 4.300 |
| 19 | 7.775 | 7.150 | 44.625 | 4.200 | 4.050 | 4.300 |
| 20 | 7.775 | 7.325 | 45.500 | 4.200 | 4.050 | 4.325@4.350 |
| 21 | 7.775 | 7.425 | 44.875 | 4.200 | 4.050 | 4.350 |
| 22 | 7.775 | 7.400 | 45.250 | 4.200 | 4.050 | 4.350 |
| 23 | 7.775 | 7.400 | 44.500 | 4.200 | 4.050 | 4.350@4.400 |
| 24 | 7.775 | 7.400 | 44.500 | 4.200 | 4.050 | 4.350 |
| 26 | 7.775 | 7.450 | 45.375 | 4.200 | 4.050 | 4.350@4.400 |
| 27 | 7.775 | 7.550 | 45.650 | 4.200 | 4.050 | 4.375@4.400 |
| 28 | 7.775 | 7.725 | 46.500 | 4.200 | 4.050 | 4.400@4.450 |
| 29 | 7.775 | 7.725 | 45.250 | 4.200 | 4.050 | 4.450@4.500 |
| 30 | 7.775 | 7.725 | 44.750 | 4.200 | 4.050 | 4.500 |
| Av. for month | 7.773 | 7.484 | 44.097 | 4.173 | 4.023 | 4.348 |
| **Averages for Week** | | | | | | |
| 7 | 7.765 | 7.600 | 41.621 | 4.100 | 3.950 | 4.325 |
| 14 | 7.775 | 7.525 | 45.146 | 4.183 | 4.033 | 4.325 |
| 21 | 7.775 | 7.263 | 44.025 | 4.200 | 4.050 | 4.317 |
| 28 | 7.775 | 7.488 | 45.296 | 4.200 | 4.050 | 4.377 |
| **Calendar Week Averages** | | | | | | |
| 3 | 7.613 | 7.421 | 40.675 | 4.060 | 3.910 | 4.295 |
| 10 | 7.775 | 7.625 | 43.663 | 4.133 | 3.983 | 4.323 |
| 17 | 7.775 | 7.329 | 44.108 | 4.200 | 4.050 | 4.317 |
| 24 | 7.775 | 7.350 | 44.875 | 4.200 | 4.050 | 4.344 |

### Silver, Gold, and Sterling Exchange New York and London

| June | Sterling Exchange: "Checks" | Sterling Exchange: "90-Day Demand" | Silver: New York | Silver: London | Gold: London |
|---|---|---|---|---|---|
| 1 | 3.99500 | 4.02000 | 34.875 | 18.8750 | 122s 11d |
| 2 | 3.99000 | 4.01000 | 35.625 | 19.0625 | 122s 5 d |
| 3 | 4.00750 | 4.03000 | 35.500 | 19.4375 | 122s 4 d |
| 5 | 4.00250 | 4.02250 | 34.750 | Holiday | ..... |
| 6 | 4.01500 | 4.03500 | 35.250 | 19.2500 | 122s 6 d |
| 7 | 4.05250 | 4.07250 | 35.750 | 19.1875 | 122s |
| 8 | 4.12500 | 4.14500 | 36.250 | 19.2500 | 122s 2½d |
| 9 | 4.10000 | 4.11750 | 36.125 | 19.4375 | 122s 4½d |
| 10 | 4.13125 | 4.15125 | 36.625 | 19.3125 | 122s 6 d |
| 12 | 4.14500 | 4.16750 | 36.750 | 19.4375 | 122s 2½d |
| 13 | 4.14500 | 4.16500 | 36.500 | 19.4375 | 122s 2 d |
| 14 | 4.08500 | 4.10500 | 36.125 | 19.4375 | 122s 1 d |
| 15 | 4.05500 | 4.07000 | 35.500 | 19.5625 | 122s 2 d |
| 16 | 4.07000 | 4.08000 | 35.250 | 19.2500 | 122s 1 d |
| 17 | 4.06750 | 4 08500 | 35.000 | 19.0625 | 122s 2½d |
| 19 | 4.14500 | 4.16500 | 36.000 | 19.1875 | 122s 2 d |
| 20 | 4.17750 | 4.19750 | 36.000 | 19.1875 | 122s 1 d |
| 21 | 4.15750 | 4.17750 | 35.000 | 19.0625 | 122s 2 d |
| 22 | 4.23250 | 4.25250 | 35.750 | 19.0000 | 122s 3 d |
| 23 | 4.21500 | 4.23500 | 34.875 | 18.5000 | 122s 2 d |
| 24 | 4.22250 | 4.24250 | 34.750 | 18.4375 | 122s 3 d |
| 26 | 4.21250 | 4.23250 | 35.125 | 18.5625 | 122s 4 d |
| 27 | 4.24000 | 4.26000 | 36.250 | 19.0625 | 122s |
| 28 | 4.33000 | 4.35000 | 36.250 | 18.9375 | 122s 4 d |
| 29 | 4.25000 | 4.27000 | 35.625 | 18.3750 | 122s 4 d |
| 30 | 4.26750 | 4.27250 | 35.750 | 18.6250 | 123s |
| Av. for month | 4.13216 | ..... | 35.663 | 19.078 | ..... |
| **Averages for Week** | | | | | |
| 7 | 4.01042 | ..... | 35.292 | ..... | ..... |
| 14 | 4.12188 | ..... | 36.396 | ..... | ..... |
| 21 | 4.11208 | ..... | 35.458 | ..... | ..... |
| 28 | 4.24208 | ..... | 35.500 | ..... | ..... |

Calendar week averages: New York Silver June 3, 35.125; June 10, 35.792; June 17, 35.854; June 24, 35.396.

### London Market

| June | Copper: Standard Spot | Copper: Standard 3 Mo. | Copper: Electrolytic Bid | Tin: Spot | Tin: 3 Mo. | Lead: Spot | Lead: 3 Mo. | Zinc: Spot | Zinc: 3 Mo. |
|---|---|---|---|---|---|---|---|---|---|
| 1..... | 38.1250 | 38.3125 | 43.0000 | 209.0000 | 208.7500 | 13.3125 | 13.5625 | 16.5000 | 16.4375 |
| 2..... | 38.0625 | 38.3125 | 43.0000 | 209.8750 | 209.7500 | 13.2500 | 13.5000 | 16.5000 | 16.4375 |
| 5..... | | | | | Holiday | | | | |
| 6..... | 38.5000 | 38.7500 | 43.2500 | 215.3750 | 215.1250 | 13.6250 | 13.9375 | 16.6250 | 16.6875 |
| 7..... | 37.5625 | 37.8125 | 42.5000 | 215.5000 | 215.6250 | 13.3750 | 13.6875 | 16.5625 | 16.5625 |
| 8..... | 37.3125 | 37.5000 | 42.2500 | 221.2500 | 221.2500 | 13.5000 | 13.7500 | 16.8125 | 16.8125 |
| 9..... | 37.2500 | 37.5000 | 42.0000 | 227.2500 | 227.2500 | 13.5000 | 13.8125 | 17.0000 | 16.8750 |
| 12..... | 35.6875 | 35.8750 | 40.5000 | 222.7500 | 222.7500 | 13.3125 | 13.6250 | 16.5625 | 16.5625 |
| 13..... | 36.2500 | 36.4375 | 40.5000 | 224.0000 | 224.0000 | 13.3750 | 13.6875 | 16.8750 | 16.8750 |
| 14..... | 35.8750 | 36.1250 | 40.5000 | 221.7500 | 221.7500 | 13.1875 | 13.5000 | 16.6875 | 16.6875 |
| 15..... | 35.7500 | 35.9375 | 40.2500 | 221.5000 | 221.5000 | 13.0000 | 13.3125 | 16.7500 | 16.5000 |
| 16..... | 34.7500 | 35.0000 | 39.5000 | 212.1250 | 212.1250 | 12.5625 | 12.8750 | 16.5000 | 16.1875 |
| 19..... | 35.4375 | 35.6875 | 39.5000 | 216.0000 | 216.0000 | 12.8125 | 13.1250 | 16.5000 | 16.1875 |
| 20..... | 37.1875 | 37.3750 | 40.5000 | 225.0000 | 224.7500 | 13.2500 | 13.5625 | 17.1250 | 16.6250 |
| 21..... | 36.0625 | 36.2500 | 40.0000 | 220.3750 | 220.5000 | 13.1875 | 13.5625 | 17.1250 | 16.7500 |
| 22..... | 36.5000 | 36.6875 | 40.0000 | 222.3750 | 221.7500 | 13.1875 | 13.5000 | 17.1250 | 16.7500 |
| 23..... | 36.3125 | 36.5000 | 40.0000 | 219.7500 | 219.0000 | 13.2500 | 13.5625 | 17.2500 | 16.8125 |
| 26..... | 36.6250 | 36.8125 | 40.5000 | 221.0000 | 220.5000 | 13.4375 | 13.7500 | 17.3750 | 17.0625 |
| 27..... | 37.3750 | 37.5625 | 41.0000 | 224.8750 | 223.8750 | 13.5000 | 13.8125 | 17.6875 | 17.3750 |
| 28..... | 37.6250 | 37.8125 | 41.2500 | 225.2500 | 224.1250 | 13.5625 | 13.8125 | 17.9375 | 17.6250 |
| 29..... | 37.0000 | 37.1875 | 40.5000 | 222.7500 | 222.0000 | 13.3750 | 13.5625 | 17.5000 | 17.1250 |
| 30..... | 36.6875 | 36.8125 | 40.5000 | 221.5000 | 220.5000 | 13.3125 | 13.5000 | 17.7500 | 17.3125 |
| Av. for month.. | 36.759 | ..... | 41.000 | 219.964 | ..... | 13.280 | 13.571 | 16.988 | 16.774 |

**The United States quotations** are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices of domestic class are in cents per pound.

**Copper, lead and zinc quotations** are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

**Quotations for zinc** are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West are based on a minimum

## Silver and Sterling Exchange

| | New York | | London Spot | | Sterling Exchange | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| January | 29.780 | 25.400 | 19.623 | 16.883 | 342.515 | 336.060 |
| February | 30.136 | 26.074 | 19.573 | 16.885 | 345.141 | 342.114 |
| March | 29.810 | 27.928 | 18.336 | 17.588 | 363.463 | 343.138 |
| April | 28.298 | 30.730 | 16.923 | 18.440 | 374.731 | 357.565 |
| May | 27.755 | 34.072 | 16.868 | 19.046 | 367.370 | 393.106 |
| June | 27.466 | 35.663 | 16.844 | 19.078 | 364.471 | 413.216 |
| July | 26.700 | ..... | 16.930 | ..... | 354.865 | ..... |
| August | 27.986 | ..... | 18.000 | ..... | 347.449 | ..... |
| September | 27.870 | ..... | 17.998 | ..... | 347.003 | ..... |
| October | 27.195 | ..... | 17.813 | ..... | 339.500 | ..... |
| November | 26.698 | ..... | 18.099 | ..... | 327.458 | ..... |
| December | 25.010 | ..... | 17.110 | ..... | 327.683 | ..... |
| Year | 27.892 | ..... | 17.843 | ..... | 350.137 | ..... |

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

## Copper

| | F.O.B. Refinery | | | London Spot | | | |
|---|---|---|---|---|---|---|---|
| | Electrolytic | | | Standard | | Electrolytic | |
| | Domestic | | Export | | | | |
| | 1932 | 1933 | 1933 | 1932 | 1933 | 1932 | 1933 |
| January | 7.060 | 4.775 | 4.741 | 39.459 | 28.557 | 46.200 | 33.244 |
| February | 5.965 | 4.775 | 4.710 | 36.917 | 28.481 | 41.381 | 32.556 |
| March | 5.763 | 5.011 | 4.779 | 33.039 | 28.179 | 36.786 | 32.370 |
| April | 5.565 | 5.395 | 5.185 | 29.943 | 29.576 | 34.190 | 33.681 |
| May | 5.237 | 6.698 | 6.569 | 28.548 | 34.071 | 32.833 | 38.163 |
| June | 5.145 | 7.773 | 7.484 | 26.872 | 36.759 | 30.841 | 41.000 |
| July | 5.053 | ..... | ..... | 26.071 | ..... | 29.107 | ..... |
| August | 5.219 | ..... | ..... | 31.401 | ..... | 34.784 | ..... |
| September | 5.978 | ..... | ..... | 34.986 | ..... | 38.318 | ..... |
| October | 5.733 | ..... | ..... | 31.890 | ..... | 36.190 | ..... |
| November | 5.131 | ..... | ..... | 31.972 | ..... | 36.568 | ..... |
| December | 4.813 | ..... | ..... | 29.088 | ..... | 34.344 | ..... |
| Year | 5.555 | ..... | ..... | 31.682 | ..... | 35.962 | ..... |

New York quotations, cents per pound. London, pounds sterling per long ton.

## Lead

| | New York | | St. Louis | | London | | | |
|---|---|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 Spot | 1932 3 Mos. | 1933 Spot | 1933 3 Mos. |
| January | 3.750 | 3.000 | 3.550 | 2.875 | 15.084 | 15.128 | 10.458 | 10.833 |
| February | 3.712 | 3.000 | 3.499 | 2.875 | 14.560 | 14.571 | 10.431 | 10.719 |
| March | 3.150 | 3.146 | 2.993 | 3.021 | 12.345 | 12.634 | 10.609 | 10.821 |
| April | 3.000 | 3.260 | 2.900 | 3.135 | 11.223 | 11.503 | 10.872 | 11.122 |
| May | 3.000 | 3.654 | 2.900 | 3.525 | 10.673 | 11.036 | 12.095 | 12.372 |
| June | 2.993 | 4.173 | 2.896 | 4.023 | 9.608 | 9.898 | 13.280 | 13.571 |
| July | 2.747 | ..... | 2.611 | ..... | 9.818 | 10.152 | ..... | ..... |
| August | 3.235 | ..... | 3.093 | ..... | 11.349 | 11.588 | ..... | ..... |
| September | 3.465 | ..... | 3.315 | ..... | 13.122 | 13.349 | ..... | ..... |
| October | 3.052 | ..... | 2.939 | ..... | 11.958 | 12.170 | ..... | ..... |
| November | 3.050 | ..... | 2.931 | ..... | 12.071 | 12.395 | ..... | ..... |
| December | 3.000 | ..... | 2.877 | ..... | 11.144 | 11.541 | ..... | ..... |
| Year | 3.180 | ..... | 3.042 | ..... | 11.913 | 12.164 | ..... | ..... |

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

## Tin

| | New York | | London | |
|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 |
| | Straits | | Spot | |
| January | 21.804 | 22.692 | 140.219 | 145.708 |
| February | 22.018 | 23.500 | 139.143 | 148.544 |
| March | 21.863 | 24.221 | 129.810 | 149.120 |
| April | 19.244 | 27.136 | 108.935 | 157.944 |
| May | 20.948 | 36.051 | 122.286 | 186.207 |
| June | 19.659 | 44.097 | 114.530 | 219.964 |
| July | 20.931 | ..... | 125.863 | ..... |
| August | 22.985 | ..... | 142.017 | ..... |
| September | 24.779 | ..... | 152.705 | ..... |
| October | 23.936 | ..... | 151.280 | ..... |
| November | 23.354 | ..... | 153.585 | ..... |
| December | 22.677 | ..... | 149.806 | ..... |
| Year | 22.017 | ..... | 135.848 | ..... |

New York quotations, cents per pound. London, pounds sterling per long ton.

## Zinc

| | St. Louis | | London | | | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 Spot | 1932 3 Mos. | 1933 Spot | 1933 3 Mos. |
| January | 3.011 | 3.018 | 14.416 | 14.834 | 14.381 | 14.595 |
| February | 2.817 | 2.666 | 13.872 | 14.289 | 13.866 | 14.119 |
| March | 2.787 | 2.987 | 12.616 | 13.024 | 14.647 | 14.674 |
| April | 2.725 | 3.298 | 11.670 | 11.958 | 14.951 | 15.208 |
| May | 2.532 | 3.805 | 12.432 | 12.682 | 15.505 | 15.660 |
| June | 2.777 | 4.348 | 11.548 | 11.866 | 16.988 | 16.774 |
| July | 2.537 | ..... | 11.592 | 11.967 | ..... | ..... |
| August | 2.758 | ..... | 13.594 | 13.844 | ..... | ..... |
| September | 3.322 | ..... | 15.455 | 15.616 | ..... | ..... |
| October | 3.027 | ..... | 14.869 | 15.140 | ..... | ..... |
| November | 3.094 | ..... | 15.264 | 15.534 | ..... | ..... |
| December | 3.124 | ..... | 15.209 | 15.347 | ..... | ..... |
| Year | 2.876 | ..... | 13.545 | 13.842 | ..... | ..... |

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

## Cadmium and Aluminum

| | Cadmium | | Aluminum | |
|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 |
| January | 55.000 | 55.000 | 23.300 | 23.300 |
| February | 55.000 | 55.000 | 23.300 | 23.300 |
| March | 55.000 | 55.000 | 23.300 | 23.300 |
| April | 55.000 | 55.000 | 23.300 | 23.300 |
| May | 55.000 | 55.000 | 23.300 | 23.300 |
| June | 55.000 | 55.000 | 23.300 | 23.300 |
| July | 55.000 | ..... | 23.300 | ..... |
| August | 55.000 | ..... | 23.300 | ..... |
| September | 55.000 | ..... | 23.300 | ..... |
| October | 55.000 | ..... | 23.300 | ..... |
| November | 55.000 | ..... | 23.300 | ..... |
| December | 55.000 | ..... | 23.300 | ..... |
| Year | 55.000 | ..... | 23.300 | ..... |

Aluminum in cents per pound, 99 per cent grade.
Cadmium, cents per pound.

## Antimony, Quicksilver, and Platinum

| | Antimony (a) New York | | Quicksilver (b) New York | | Platinum (c) New York | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| January | 5.976 | 5.722 | 64.900 | 48.500 | 40.000 | 26.480 |
| February | 6.489 | 5.738 | 66.304 | 48.614 | 40.000 | 24.000 |
| March | 6.188 | 5.901 | 72.537 | 52.676 | 40.000 | 24.667 |
| April | 5.746 | 5.876 | 72.125 | 54.580 | 40.000 | 26.800 |
| May | 5.170 | 6.264 | 66.380 | 56.500 | 39.500 | 28.500 |
| June | 5.034 | 6.500 | 59.481 | 60.038 | 37.500 | 30.000 |
| July | 5.000 | ..... | 53.580 | ..... | 35.200 | ..... |
| August | 5.144 | ..... | 47.444 | ..... | 35.000 | ..... |
| September | 5.606 | ..... | 47.500 | ..... | 33.800 | ..... |
| October | 5.575 | ..... | 47.600 | ..... | 33.000 | ..... |
| November | 5.771 | ..... | 48.750 | ..... | 33.000 | ..... |
| December | 5.400 | ..... | 48.500 | ..... | 30.462 | ..... |
| Year | 5.592 | ..... | 57.925 | ..... | 36.455 | ..... |

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

## Pig Iron

| | Bessemer | | Basic | | No. 2 Foundry | |
|---|---|---|---|---|---|---|
| | 1932 | 1933 | 1932 | 1933 | 1932 | 1933 |
| January | 16.00 | 14.50 | 15.00 | 14.00 | 15.50 | 14.50 |
| February | 15.68 | 14.50 | 14.68 | 14.00 | 15.18 | 14.50 |
| March | 15.50 | 14.50 | 14.50 | 14.00 | 15.00 | 14.50 |
| April | 15.50 | 14.50 | 14.50 | 14.00 | 15.00 | 14.50 |
| May | 15.50 | 15.42 | 14.50 | 14.42 | 15.00 | 14.92 |
| June | 14.85 | 16.00 | 14.35 | 15.00 | 14.75 | 15.50 |
| July | 14.56 | ..... | 14.00 | ..... | 14.50 | ..... |
| August | 14.50 | ..... | 14.00 | ..... | 14.50 | ..... |
| September | 14.50 | ..... | 14.00 | ..... | 14.50 | ..... |
| October | 14.50 | ..... | 14.00 | ..... | 14.50 | ..... |
| November | 14.50 | ..... | 14.00 | ..... | 14.50 | ..... |
| December | 14.50 | ..... | 14.00 | ..... | 14.50 | ..... |
| Year | 15.01 | ..... | 14.29 | ..... | 14.79 | ..... |

Iron in dollars per long ton freight to Pittsburgh, $1.89

F.o.b. Mahoning and Shenango Valley furnaces,

price basis of 4½c. per pound.

**Quotations for lead** reflect prices obtained for common lead, and do not include grades on which a premium is asked.

**London prices for lead and zinc** are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

**New York silver quotations** are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, 925 fine. Sterling prices represent forenoon market demand. Cables command a premium.